JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

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Chapters of the Association have been organized in important cities in the United States. Information concerning the meetings of these chapters may be secured from the District Representatives listed on another page.

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JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

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INDUSTRIAL PRODUCTIVITY AND PRICES*

By Frederick C. Mills
National Bureau of Economic Research

I

The influence of industrial change on production and on the well-being of different economic groups has long been a matter of concern to economists. With the development of highly integrated industrial systems, the mechanization of industry and the speeding up of technological change the problems raised by technical progress have become more acute. The economic and social consequences of industrial changes are felt on a wider front, and adaptation to them may involve much more extensive readjustments.

Contemporary thought on the nature and consequences of technical and organizational advances reflects, in some degree, views that stem from J. B. Say and James Mill, in the classical controversy on the possibility of general over-production. Yet the simple lines of the earlier theory have been blurred, and far more diverse issues have been stressed in recent discussion. A facile dismissal of the problem on the assumption that an automatic adjustment to industrial shifts is effected, with re-employment of all displaced productive factors, is no longer possible. Technical change is a many-sided process that affects economic institutions and economic activities in numerous ways. The opportunities open to entrepreneurs; the flow of savings; the kind of capital goods required; the rate of obsolescence; the soundness of existing investments and of the debt structure that rests upon them; the amount of labor needed and the kind of skills required in the working force; costs and prices and the distribution of purchasing power—all these are directly affected by changes in productive technique. Moreover, the problems raised by technical changes may be quite different at different times and under different conjunctural conditions. It is a

* Revision of a paper presented at a joint session of the American Economic Association and the Conference on Price Research, Chicago, December 29, 1936.

problem that calls for realistic, first hand study, that is both intensive (in its bearing on the fortunes of single industries and industrial groups) and extensive (in its bearing on the production structure as a whole and on the working of the price and credit systems).

II

Something has been done toward the measurement of changes in industrial productivity in aggregative terms, with reference to all manufacturing industries or great groups of industries. Setting total manufacturing output against the total number of men employed or man-hours worked at different times, certain relations bearing on productive efficiency may be determined. But here, perhaps more definitely than in most fields of economic research, a specialized attack is needed. Technical conditions differ so profoundly from industry to industry that abstract measurements based on industrial aggregates fall far short of our needs. By focussing studies on individual plants and industries and the fortunes of specific groups of producers and consumers we may hope to get accurate measurements of productivity, a true understanding of the extent and character of technological changes in productive methods and information as to the direct economic consequences of such changes. The present paper deals with specific procedures that may be employed in measuring productivity changes and, more particularly, in tracing the incidence of such changes.

The manner in which a given advance in productivity may be exploited, and resulting gains divided, is obviously dependent on the prevailing form of economic organization. In a centrally controlled economy the executive authority might utilize the energy released by the advance to expand the production of consumer goods or of capital equipment, to augment the rewards of producing groups, or to increase the leisure time available to producers. A conscious decision would determine the division of the gains of enhanced productivity. The factors are more complex in an industrial economy marked by a high degree of division of labor and operating within a price system that is partly competitive, partly subject to private and public control. The first effect of a mechanical or administrative innovation in a going economy is to alter the physical organization of a producing unit. The numerical relations of men to machines, of hours of direct effort to units of output, of machines to units of output, of skilled to unskilled men, of wage-earners to salaried workers are altered. Through the system of prices these physical alterations affect the rewards of various agents of production and the costs to consumers. The pulling and

hauling of competing forces, complicated by intervening frictions of many sorts, work, through prices, to determine how the benefits potential in a given industrial improvement shall be exploited and divided.

We may approach the task of tracing the incidence of productivity advances by considering some elements of the problem in simplified form. Assume that for a given industry we have measurements of the following factors:

Q = Quantity of goods produced, in physical units.
E = Effort expended in production, in energy units.
S = Sum, in dollars, for which the total product is sold. (Assume that the goods are sold directly by producers to final consumers; this is the sum paid by consumers and received by producers.)
P_1 = Index of prices of goods and services sold by consumers of the products of the industry in question. (Through the sale of these goods and services consumers acquire the sum S, wherewith to buy the products represented by Q.)
P_2 = Index of prices of goods and services bought by the producers of the goods represented by Q.

In using these measurements to trace changes over time, two conditions are necessary to complete accuracy:

1. Changes in the character of the goods represented by Q are open to quantitative definition. Important quality changes that may not be reduced to measurable terms render the index of volume of output inaccurate.

2. Productivity changes in the output of goods and services represented in P_1 are open to measurement. It is assumed that we are able to define changes in the aggregate effort expended by consumers in producing the goods and services sold in securing the sum S.

When these conditions are met, and the five basic series of data are available, changes in productivity may be measured and division of the resulting gains traced with precision.

The use and interpretation of these measurements may be discussed with reference to a series of hypothetical figures relating to conditions at two different dates.

Over the period here considered the total volume of production increased 80 per cent; total productive effort expended increased 44 per cent (it is assumed that this includes the productive contribution of any new capital equipment employed in effecting the increase in output); the gain in productivity, that is, in output per unit of effort expended, was 25 per cent. The total amount of money paid by consumers (and received by producers) for the goods represented by Q increased 116 per cent; the per unit price went up by 20 per cent.

If we are to determine how the results of the gain in productivity were actually divided, as between producers and consumers, we must pass from the money level to the level of real costs and real rewards for these two groups. The index P_1 shows that there was an increase of 25 per cent in the prices of the goods and services produced and

Series	*Time "1"*	*Time "2"*
Q	100	180
E	100	144
S	100	216
P_1	100	125
P_2	100	125
Derived Measurements		
Q/E = Physical output per unit of productive effort	100	125
E/Q = Real cost, in effort expended, per unit of goods produced	100	80
S/Q = Selling price, per unit of goods produced; money cost, to consumers, per unit of goods purchased	100	120
S/E = Returns of producers in dollars, for each unit of productive effort expended	100	150
$S/P_1 = S_1$ = Sum paid by consumers corrected for changes in the prices of goods and services sold by consumers in acquiring this sum; index of aggregate effort expended by consumers in acquiring the money spent on products Q; real cost to consumers of goods purchased for S dollars	100	172.8
$S/P_2 = S_2$ = Sum received by producers for goods sold, corrected for changes in the prices of the goods and services purchased with these receipts; index of aggregate real rewards of producers, for effort expended in producing goods Q	100	172.8
S_1/Q = Real cost to consumers per unit of goods purchased	100	96
S_2/E = Real rewards of producers for each unit of productive effort expended	100	120

sold by the consumers of the products represented by Q. Accordingly, the increase from 100 to 216 in the sum expended by consumers represents an increase from 100 to 172.8 in the actual volume of goods and services which consumers give for the products, Q. We have represented this volume by S_1, which we may take to measure changes in the aggregate real costs to consumers of the goods represented by Q. Since the quantity of goods received by consumers (Q) increased by 80 per cent, while the quantity of goods and services given by them in

exchange (S_1) increased by but 72.8 per cent, consumers have reaped some advantage from the advance in productivity. The measure of this gain, on a per unit basis, is afforded by S_1/Q, which indicates a drop of 4 per cent in real cost to consumers, per unit of goods purchased.

Under conditions of increasing productivity (barring changes due to other forces) the ratio S_1/Q may be expected to fall between the limits 1.00 and E/Q. With no change in real per unit costs to consumers the ratio would stand at unity; the change in the volume of goods received by consumers (Q) would be exactly equal to the change in the volume (S_1) of goods and services given by them in exchange for these goods. If the full benefits of enhanced productivity were passed on to consumers the ratio S_1/Q would decline to the limit E/Q; the real cost of a unit of goods to consumers would be reduced by an amount equal to the reduction in effort expended by producers, per unit of goods produced. In the present example, E/Q declined 20 per cent; S_1/Q declined 4 per cent. One-fifth of the gains due to higher productivity accrued to consumers.

Turning to producers, we have an increase from 100 to 216 in the sum received for the goods produced. But the index P_2 shows an advance of 25 per cent in the average price of the goods and services bought by the producing groups with the money received from the sale of the goods, Q. Accordingly, the increase of 116 per cent in expenditures brought an advance of 72.8 per cent in real income, income in goods and services. (This is measured by S_2, secured by deflating S by P_2.)

Against the gain of 72.8 per cent in the aggregate real rewards of producers we may set the advance of 44 per cent in the total effort expended in production (as measured by E). The ratio S_2/E defines changes in the real rewards of producers, per unit of productive effort expended. This shows a gain of 20 per cent from time "1" to time "2."

The relation of the real gains of producers to the actual gain in productivity is shown by a comparison of S_2/E with Q/E. S_2/E may be expected, under conditions of increasing productivity, to fall between unity (representing no change in the real income of producers, per unit of effort expended) and Q/E. If the full benefits of the gain in efficiency were kept by producers, S_2/E would advance to the limit Q/E. In the present example Q/E shows a gain of 25 per cent in output per unit of effort expended; the real rewards of producers increased 20 per cent, per unit of effort expended. Four-fifths of the gains due to higher productivity accrued to producers.

The figures we have used are, of course, hypothetical.[1] The example serves, however, to indicate the major relations involved in tracing the results of actual changes in productivity, and to suggest a means of making the important transition from the money level of costs and rewards to the physical level of efforts and goods. If measurements approximating those assumed above may be secured for individual industries, something of value may be learned from them.

III

From records of output, labor time expended and value of fabricational operations in meat packing industries, and from supplementary price records, the following index numbers have been constructed.[2] (At a later point I discuss various qualifications relating to the approximations here employed.)

During the six years of expansion from 1923 to 1929 the volume of

Ideal measurement	*Approximation*	1923	1929	1929	1933	1935
Q	Q (Physical output of meat packing industry)	100	102	100	96	86
E	MH (Number of man-hours worked)	100	94	100	82	76
S	VA (Value added by manufacture)	100	112	100	62	72
P_1	P_1	100	109	100	70	90
P_2	P_2	100	97	100	75	82
Q/E	Q/MH	100	109	100	118	112
E/Q	MH/Q	100	92	100	85	89
S/Q	VA/Q	100	110	100	65	84
S/E	VA/MH	100	120	100	76	94
$S/P_1=S_1$	$VA/P_1=S_1$	100	103	100	89	80
S_1/Q	S_1/Q	100	101	100	92	94
$S/P_2=S_2$	$VA/P_2=S_2$	100	116	100	83	88
S_2/E	S_2/MH	100	123	100	102	115

[1] Indeed, there is a forced agreement between the real rewards of the consumers and producers here presented, making their respective gains of one-fifth and four-fifths total 100 per cent of the actual advance in productivity. This results from the identity of P_1 and P_2. It is assumed that the goods sold by consumers, in securing their money incomes, advanced in price by exactly the same percentage as did the goods bought by producers in converting their money incomes into real incomes. This is an identity not to be expected in fact. Unless the measurements of output and effort are all-inclusive, economic agents other than the producers and consumers in question intervene, and these may absorb part of the gain.

[2] Basic records for the meat packing industry are from the Census of Manufactures. Figures on total employment (man-hours) have been derived from Census data on number employed and from compilations of the National Industrial Conference Board and the U. S. Bureau of Labor Statistics on average hours worked per week. The index P_1 is a weighted average of prices received by farmers, wholesale prices of raw non-farm products, hourly earnings of wage workers and average salaries in manufacturing industries. The index P_2 is a weighted average of the cost of living of industrial wage-earners, the prices of processed capital equipment, at wholesale, and the prices of all commodities, at wholesale.

output in meat packing increased 2 per cent; the number of man-hours worked (an approximation to the measurement of productive energy expended in production) declined 6 per cent. Total value added by manufacture (i.e., cost of fabrication plus profits) increased 12 per cent. This we take to be the sum for which the total product is sold—the product, in this case, being the contribution of meat packers in slaughtering and in packing meat products. Over the same period, the prices of the goods and services sold by consumers of the products of this industry showed an average advance of 9 per cent. (Consumers are here assumed to be made up of wage-earners, salaried workers, farmers and other primary producers.) The average prices paid by those engaged in meat packing, in purchasing means of livelihood and in investing savings, declined 3 per cent.

From these figures we derive the required measurements of productivity changes and their incidence. From 1923 to 1929 output per man-hour advanced 9 per cent. But the cost of fabrication (plus profits), in dollars, went up 20 per cent per man-hour. Taking account of the advance in prices received by consumers for the goods and services sold by them in securing their incomes, we find an advance of 3 per cent in the total real cost to consumers of the services of those engaged in meat packing. (This is the magnitude defined by S_1.) But this is the cost of an increased quantity of meat products. Per unit of goods purchased the real cost to consumers advanced 1 per cent, in spite of a decline of 8 per cent in the effort required to produce one unit of the product. Turning to the producing side, we find an advance of 16 per cent in the physical volume of goods producers could buy with the sum received for their packing operations (this is measured by the index S_2). But since the effort expended (as approximated by the measure MH) had declined somewhat, this represents a gain of no less than 23 per cent in the real rewards of producers for each man-hour worked.

In spite of the substantial gain in productivity, the real cost, to consumers, of meat packing operations advanced somewhat. The gains of higher productivity accrued entirely to agents of fabrication. Indeed, their gains on a per unit basis greatly exceeded the gains due to higher productivity. The higher costs to consumers appear, on this side of the balance sheet, as higher rewards of producers.

Comparison of this record with that of the four years of recession throws an interesting light on the developments of the two periods.[3]

[3] In making such a comparison we may not ignore the widely different conditions prevailing in the two periods. Many factors other than productivity changes affect the rewards of producers and costs to consumers over any period of time. Such other forces were particularly strong from 1929 to 1933.

The production of meat packers declined from 1929 to 1933, but productivity increased 18 per cent per man-hour worked. Cost of fabrication, per unit of product, declined 35 per cent in current dollars, during this period of general price decline. This decline exceeded the fall in P_1 (prices received by consumers for their productive efforts), so there was a net reduction, amounting to 8 per cent, in the real cost of meat packing processes to consumers, per unit of goods purchased. At the same time, the real rewards of producers (this includes, of course, wage-earners, salaried workers, owners, recipients of interest and others whose compensation is included in the blanket sum represented by "value added") advanced about 2 per cent per man-hour worked.[4]

From 1933 to 1935 total output declined substantially; output per man-hour was reduced; cost of fabrication per unit of product rose. Real costs to consumers advanced slightly, and the real rewards of producers increased materially. The six years of recession and recovery had brought a notable gain to producers, per unit of effort expended, a smaller reduction of real costs to consumers, per unit of goods purchased.

We should note that the approximations employed in this example fall short, in many cases, of the ideal measurements we should like to have. The records of productive effort expended are inadequate, for we have taken no account of possible changes in the contribution of capital equipment. In passing from the money level of costs and rewards to the level of "real" costs and rewards, use has been made of

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Moreover, productivity changes during years of recession may reflect the influence of special circumstances (such as the closing of less efficient plants and the discharge of less efficient help) which do not affect productivity during a period of expansion. This last point is hardly relevant to the record of the meat packing industry, since production was well maintained during the recession.

[4] It will be noted that the gains of producers (2 per cent, against an increase of 18 per cent in productivity) and of consumers (8 per cent reduction in costs, against a reduction of 15 per cent in real costs) fall short of the total gains of this period. The explanation is found in the discrepancy between P_1 (prices received by consumers for the goods and services they sell) and P_2 (prices paid by producers in converting their money income into real income). The first of these shows a drop of 30 per cent from 1929 to 1933, the second a drop of 25 per cent. Only with perfect equality of change would the total rewards of these two groups exactly equal the gains due to higher productivity.

The failure of the two price indexes to agree may be due to errors of measurement, arising from inaccuracies in the price records utilized, or to the omission of important groups of consumers. It could also arise if part or all of the gains of higher productivity accrued to economic agents other than those producing and consuming the products of the meat packing industry. We may, for the sake of simplicity, assume the existence of a single additional group, buying the services of consumers (of meat products) and selling goods and services to the producers (of meat products). This third group could, by reducing the prices paid to consumers for their services and maintaining or advancing the prices charged to producers, secure for itself all the benefits of higher productivity in meat packing. Reality in market relations is, of course, more complex than this, but in some such fashion the gains of industrial productivity may be diverted to intermediary agencies—lost in the interstices of the price system. This could occur, we should note, only when we are dealing with a portion of the total productive and consumptive activities of the economy. If we have measurements relating to all productive activities no economic group would lie without the circle of producers and consumers with whose fortunes we are dealing.

available, but incomplete, measurements bearing on changes in the money value of consumers' services and the money cost of goods purchased by producers. Moreover, we have assumed that no changes occurred in the productivity of labor in the activities from which consumers' incomes were derived. Some error may have been introduced here, but it is probably not a great one, over the short periods covered.

In this example we have treated S (that is, the sum of money measuring total "value added" in meat packing) as a single item. It is possible to distinguish certain of its more important components, among both producing and consuming groups. For wage-earners in meat packing we have the measurements set forth below:

	1923	1929	1929	1933	1935
Q (Physical production)	100	102	100	96	86
MH (Man-hours worked)	100	94	100	82	76
Q/MH (Output per man-hour)	100	109	100	118	112
W (Total wage bill)	100	99	100	68	82
P_2 (Cost of living for industrial wage-earners)	100	100	100	76	81
W/Q (Labor cost per unit of product)	100	97	100	70	96
W/MH (Wages per hour)	100	105	100	83	108
$W/P_2 = S_2$ (Aggregate real rewards of wage-earners)	100	99	100	89	102
S_2/MH (Real wages per hour)	100	105	100	109	133

Concurrently with an increase of 9 per cent in output per man-hour over the first period labor cost per unit of product declined 3 per cent, and wages per man-hour, in current dollars, advanced 5 per cent. But chief significance attaches to two figures relating to changes in the level of real rewards—that is, to the aggregate real rewards of wage-earners and to real rewards per man-hour. The first of these shows a decline of 1 per cent from 1923 to 1929, the second an advance of 5 per cent. The advance in real wages per man-hour, though substantial, fell short of the increase in man-hour output. Other economic groups shared in the gain.

The four succeeding years of recession (during which output per man-hour increased 18 per cent) brought a decline of 30 per cent in labor costs per unit of product, a fall of 17 per cent in wages per hour. Turning to the two measurements that are needed properly to appraise the circumstances attending given changes in productivity, we find that real wages per hour advanced 9 per cent, while the aggregate real rewards of labor (i.e., the total stream of goods purchasable by wage-earners in the meat packing industry) dropped 11 per cent. Per unit of effort expended labor gained substantially during the recession but aggregate returns were reduced, because of the great decline in employment.

Total output and man-hours dropped from 1933 to 1935, productivity declined and the wage bill increased. Comparing the 1935 situation with that of 1929 we find the loss in the aggregate returns of labor that the depression had brought was more than made up by 1935, and man-hour returns were substantially greater. The gain of 33 per cent in real wages per hour materially exceeded the advance of 12 per cent in man-hour output.[5]

In like manner we may trace the fortunes of different consuming groups, who were lumped together in the preceding general account.

In interpreting these measurements we must compare them with the index MH/Q that defines the change in productive effort (as measured by man-hours worked) required to fabricate one unit of meat products. This indicates a drop of 8 per cent from 1923 to 1929 in the real cost of meat packing, per unit of product. Against this we find a decline of 8 per cent in real costs to salaried workers in manufacturing, and advances ranging from 2 to 19 per cent in the real cost to wage-earners, farmers and other primary producers. In general consumers paid more for the services of meat packers, although real production costs declined.

The four years of recession brought diverse results. In spite of a decline of 15 per cent in the effort needed to produce a unit of goods, the real cost of meat packing operations, per unit of goods purchased, increased 35 per cent for farmers and 1 per cent for salaried workers in manufacturing industries. The prices received by these groups for their goods and services declined more than did the cost of fabrication in meat packing industries. Costs to wage-earners and to primary producers other than farmers dropped substantially, however. The net result, as we have seen, was a substantial gain for consumers in general. The two following years of recovery (to 1935) lowered real costs of meat packing operations to farmers, as consumers, and increased such costs to wage-earners and producers of non-agricultural raw ma-

[5] A similar analysis of the returns of "ownership and management" in the meat packing industry is possible, using as S (the aggregate money value of their product) total value added by manufacture, less wages. (This is a mixed composite, including salaries, interest payments, rentals, depreciation charges and profits, as well as tax payments and other miscellaneous items.) It is difficult, however, to secure an acceptable approximation to E, the index of productive effort expended by this group. Available records indicate an advance of 22 per cent in the receipts of this group, between 1923 and 1929, a rise of 19 per cent in overhead costs plus profits, per unit of product. Correcting monetary receipts by an index of prices paid, we have a gain of some 28 per cent in the aggregate real rewards of ownership and management. This advance substantially exceeded the gain in productivity.

From 1929 to 1933 overhead costs plus profits declined 40 per cent; per unit of product the drop amounted to 38 per cent. Over the six years from 1929 to 1935 there was a drop of 34 per cent in aggregate overhead costs plus profits, a fall of 23 per cent in overhead plus profits per unit of product. Aggregate returns to ownership and management, corrected for price changes, dropped about 20 per cent from 1929 to 1933, showed no change from 1933 to 1935.

A. Index numbers of prices received by various consuming groups for goods and services sold (P_1):

	1923	1929	1929	1933	1935
By farmers (average price received for products sold)	100	103	100	48	74
By wage-earners (average hourly wage)	100	107	100	76	94
By salaried workers, manufacturing industries (average annual salary)	100	120	100	64	*
By primary producers, non-agricultural (average price of products at wholesale)	100	92	100	73	82

B. Index numbers of aggregate effort expended by various consuming groups in acquiring the money spent on products Q (i.e., the money represented by "value added" in meat packing) ($VA/P_1=S_1$):

	1923	1929	1929	1933	1935
Effort expended by farmers	100	109	100	130	98
Effort expended by wage-earners, general	100	104	100	82	76
Effort expended by salaried workers, manufacturing industries	100	94	100	98	*
Effort expended by primary producers, non-agricultural	100	122	100	86	88

C. Index numbers of real cost, to consumers, of meat packing operations, per unit of meat products purchased (S_1/Q):

	1923	1929	1929	1933	1935
Real cost to farmers	100	107	100	135	114
Real cost to wage-earners, general	100	102	100	85	89
Real cost to salaried workers, manufacturing	100	92	100	101	*
Real cost to primary producers, non-agricultural	100	119	100	89	102

* Data not available.

terials. The status of wage-earners remained distinctly better than in 1929, however.

IV

In seeking to approximate the ideal measurements through which the character and incidence of changes in industrial productivity and in industrial costs may be defined, I have made use of data not gathered in the first instance with reference to the problems with which we are here concerned. These data do not meet our needs. Direct studies on the ground may be expected to yield more precise data, more suitable to the purpose in mind. It is appropriate to suggest ways in which more satisfactory measurements may be secured.

a. Strict comparability among the three major measurements (and subordinate items) is essential. These measurements are those represented by Q (physical output), E (productive energy expended) and S (the value series corresponding to Q). In compiling data relating to a given plant or industry effort should be made to ensure that the man-hours or other energy units defined in E represent all the effort (and no more) put into the production of the goods represented by Q, and that the value series represented by S relate to the exact physical units represented by Q. Full comparability is not easy to achieve, particularly when changes over time are being traced; usually we have to be content with something less than perfection. But if Q, E and S do not relate to exactly the same area of activity, there should be no important variations from time to time in their respective degrees of coverage.

b. High accuracy should be sought in the index of physical output. Changes in quality are perhaps the chief disturbing factor here. When a quality change is open to definition and reduction to quantitative terms (as when an instrument is made 40 per cent more efficient), the index of physical output may be modified to take account of it. Only when no quality changes occur, or when such changes may be reduced with some precision to quantitative terms, may changes in productivity and in costs be traced in satisfactory fashion.

c. Perhaps the greatest difficulties are faced in the exact measurement of productive energy expended. It has been customary, in default of better standards, to define productivity in terms of output per capita, this usually meaning output per wage-earner employed in direct production. If measurements of this type extend over time they are subject to three defects. Hours of labor are subject to change; the quality of labor (the degree of training and skill required in the working force) may change; the ratio of direct labor to indirect labor (embodied in capital equipment and employed in a variety of indirect productive services) may vary materially. The "per capita" standard may be improved, when information as to average hours worked per week is to be had, by measuring changes in output per man-hour worked. It is more difficult to allow for changes in the quality of the labor entering into production. If records of hourly wage rates are available the index of total man-hours worked in a given period may be a weighted aggregate, man-hours of effort at different levels being weighted by corresponding wage rates. Such weighting may not be appropriate to all purposes. Indeed measurements of productivity lose in direct physical significance when a value factor is thus introduced.

Problems of another order are faced in seeking to take account of

labor indirectly entering into production. When the amounts of servicing, supervising and subsidiary labor are known, they maybe combined, properly weighted, with direct labor. The matter is more complicated for labor represented in the technical instruments of production.

When we are dealing with the output of a whole economy the quantity Q (constituting the numerator of the fraction Q/E) includes, over a stated period, the production of all goods intended for consumption, plus net additions to the capital equipment of the economy. The corresponding index, E, of productive effort expended should include all labor expended on the production of goods intended for consumption, plus labor employed in producing additions to capital equipment plus labor expended in the *maintenance* of all equipment existing at the beginning of the period. The productive contribution, over the period covered, of pre-existing equipment is measured by the labor required to maintain that equipment at the level of efficiency prevailing at the opening of the period. (The labor expended in producing that equipment will have been set off against the equipment itself in periods prior to that with which we are here concerned.)

In dealing with a single industry a somewhat different procedure is needed. Here the index Q, for any period, must include all the goods produced for sale by that industry, whether they be intended for human consumption or for capital equipment. The index E, of productive effort expended, must include the total man-hours of labor time (including the time of salaried employees), plus the man-hours of time required to maintain the equipment that was in use at the beginning of the period.[6] Accurate annual depreciation charges, duly corrected for changes in costs arising out of variations in the value of money, provide acceptable current measures of this effort. Reduced to relative numbers, and appropriately weighted, this element may be combined with the index of labor time to give a measurement of total effort expended in production.[7]

[6] If part of the industry's productive effort is used to produce new equipment for its own use, such additions to capital equipment would be added to the index Q, and the corresponding effort added to the index E.

[7] The difficulty lies, of course, in securing accurate depreciation charges. These are seldom available, even in the detailed accounts of individual enterprises.

A rough indication of the relative importance of this factor in the meat packing industry may be secured by estimating depreciation charges for the entire industry from the published statements of three large companies. We obtain figures of 27 millions of dollars for 1929, 19 millions for 1933. (The total wage bill of the industry in 1929 was 166 million dollars.) Correcting these depreciation charges for changes in the cost of capital equipment, and combining with the index of man-hours of labor, we have an index E (effort expended in production) for 1933 (on the 1929 base) of 80, in place of the index 82, relating to man-hours alone. The corresponding index of productivity for 1933, on the 1929 base, becomes 120, as compared with the measure of 118 computed for man-hours alone. A similar calculation yields a productivity index of 114 for 1935, on the 1929 base, as against an uncorrected index of 113. The depreciation estimates are rough, but the corrected indexes are probably closer to the truth, since some account is taken of the changing contribution of capital equipment.

In many cases it is not possible to extend the index of productive effort beyond the simple record of man-hours expended by wage-earners. When the index is thus restricted we must recognize that the instruments used by wage-earners and the ratio of supervisory and ancillary labor to direct labor vary over time. The usual result of this restriction, in a period when capital equipment is being augmented, is an over-statement of actual gains in productivity; in a period of general contraction the error may lie in the other direction. Information concerning capital investment will supplement the measurements of productivity and aid in their interpretation.

d. Knowledge of the component elements of S, the total sum received by the producers of the goods represented by Q, is required in a study of the division of productivity gains. In the preceding example total fabrication costs have been broken into portions accruing to wage-earners and to "ownership and management." The last item is a heterogeneous mixture, which should be broken down further. The sums constituting overhead proper should be distinguished from profits; interest and salary payments should be distinguished from other elements of overhead; tax payments should be separately measured. This division of the total sum received for the products sold makes it possible to measure production costs (average costs)[8] and changes therein, and is essential to tracing the true incidence of changes in productivity.

e. Beyond the field of industry studies proper, but of profound importance in measuring the consequences of changes in productivity and the actual allocation of economic gains, lies the task of constructing the indexes P_1 and P_2. These are the measurements of changes in the prices of goods and services sold by consumers and of goods and services bought by producers. The task is that of constructing bridges for passage from the money level of costs and rewards to that of real costs and real rewards. The deficiencies of monetary records of wage and salary rates and of income have been made obvious by the wide price swings of recent years. Equally faulty are quoted prices as measurements of the actual costs, to consumers, of goods and services purchased. For a dollar of money income, to be expended by a consumer, may at different times represent quite different outlays of effort on the part of the income recipient. Account must be taken of variations in the prices received by consumers for their productive efforts if we are accurately to definite the results of technical progress.

[8] Since the analysis proceeds from measurements of aggregate output and aggregate costs and value to unit costs and unit selling prices, it is limited to average costs and corresponding rewards. The refinement of analysis that would be made possible by detailed records of differential costs is not here discussed.

It is not enough to know that productive efficiency in manufacturing has increased 20 per cent. We should know what effects this may have on the real costs of manufactured products to consumers. This is true even though we are concerned only with the fortunes of a single industry. It is doubly true when we are interested in the broader effects of technical progress on standards of living, on the utilization of productive resources, and on the amount and character of employment available to industrial labor.

The deflating indexes appropriate to our needs in passing from money levels to real levels must be numerous, and adapted to specific groups of consumers and producers. The task of constructing these is not for those engaged in studying particular industries. It is a proper task for bodies with broader responsibilities, for research agencies and federal bureaus.

V

The influence of machine technology on the fortunes of economic classes and the division of economic power has been a subject of discussion in economic literature since the full force of the industrial revolution was felt in nineteenth century England. The present paper has dealt with some of the contributions that detailed field studies of American industries may make to our knowledge of technical progress and its consequences. In place of sweeping generalizations based on limited observation we need a body of knowledge derived from intensive investigations. Important contributions have already been made by Barnett in his pioneer work on the glass industry, by Elizabeth Baker on the printing trades, by the United States Bureau of Labor Statistics, by the Minnesota Employment Stabilization Research Institute, and by Jerome in his comprehensive study of mechanization. The survey of productivity and industrial techniques that is now being conducted by the Works Progress Administration and associated agencies will yield further knowledge. Such concrete studies of productive operations and of requirements will give us an appreciation of the true inwardness of the machine age.

It is clear that for an understanding of the role played by changing technology today we must go beyond the record of changing techniques in individual industries. Mechanical and managerial changes affect economic organization and the lives of the human elements of that organization through the system of prices—through their influence on returns to capital, on profits, on wages and wage rates, and on the purchasing power of individuals and groups. The incidence on prices of changes in production lies at the heart of the problem raised by industrial change.

The working of a modern economy involves contact between productive energies and purchasing power. A gain in productivity brings, on the one hand, a release of productive energies; less effort is required for the production of a given quantity of goods. On the other hand, a gain in productivity brings (almost invariably) a shift in the distribution of purchasing power, a shift from group to group or a change in the distribution within a group. The essential problem of readjustment is that of establishing a connection between the released productive energy and the purchasing power thus shifted. Under contemporary conditions this connection can be established only through the system of prices. Whether it be directly and readily established, with only temporary dislocation, or whether the process be long drawn out, with protracted unemployment of productive resources, depends in good part upon the original incidence of the change and upon the number and character of the frictions retarding a realignment of productive agencies and a readjustment of producer-consumer relations. In an economy marked by numerous frictions the pains of readjustment may be minimized, as I have suggested elsewhere, when the gains of industrial progress are widely diffused.[9] When the gains are narrowly restricted the economy may operate for an extended period at an inefficient level.

[9] See *Prices in Recession and Recovery*, National Bureau of Economic Research, New York, 1936.

HIGHLIGHTS OF THE 1935 CENSUS OF BUSINESS*

By F. A. Gosnell
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The 1935 Census of Business is the most comprehensive business statistical undertaking that has ever been known. It is interesting to check the growth of this enterprise since its beginning in 1927. In that year a test Census of Retail and Wholesale Trade was made covering 11 cities, in which there were collected 111,000 schedules. The 1929 Census of Distribution included retail and wholesale trade, hotels, construction, and distribution of sales by manufacturers. There were 1,873,000 business units included in that census. The scope of the 1933 Census of American Business was changed so as to include service establishments and places of amusement and exclude construction and distribution of sales. During that year there was a total of 2,193,000 reporting establishments. The 1935 Census of Business includes retail and wholesale trade, service establishments, places of amusement, hotels, construction, bus and truck transportation, radio broadcasting, insurance and real estate, advertising agencies, warehousing, banking and finance, distribution of sales by manufacturers, and the operation of commercial and other non-residential buildings, for which there have been obtained approximately 3,000,000 reports.

The information for the 1929 census was obtained on 15 comprehensive schedule forms. In 1933 the information was collected on a single form which was prepared in such a way as to obtain basic facts only from all kinds of business coming within the scope of that census. In 1935 we have used 16 schedule forms which provide more or less detailed information covering various fields of business. In determining the detail in which the information should be obtained, consideration was given to the availability of statistical information from all Governmental sources so as not to duplicate the work of other agencies. It was decided, for example, that the only essential additional information that should be obtained for banks and financial institutions was employment and pay roll data by occupational classes. In contrast, the wholesale questionnaire, counting each commodity item separately, included more than 300 questions for which we attempted to obtain information.

Most of you are familiar with the type of tables that are used in presenting the results of a Business Census. I shall, therefore, not

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discuss these tables other than to give you a brief report on the progress that is being made in their production and publication.

The first complete report of the Census of Business covered radio broadcasting. The second was the preliminary summary on Retail Trade, published on October 15, 1936. Until this report was issued, no one knew to what extent retail trade in the United States had recovered from the depths of the depression which, I believe, was pictured fairly accurately by the 1933 Census of American Business.

On October 22 there was published a preliminary report on service establishments, followed by the United States Summary for Wholesale Trade, released on November 27.

Each of these reports contains basic information on the number of business establishments, their net sales or operating receipts, employment and pay roll during 1935. In the Retail and Service reports, the data are shown for each state, each county and each city of more than 2,500 population. Data on Wholesale Trade are presented for states and for counties and for cities of more than 5,000 population.

Within a few days the Retail type volume will be issued, presenting basic facts for independents, chains and other types for states and for cities having a population of more than 500,000. As in previous censuses, the type tabulations are limited primarily to the kinds of business in which chains operate.

One of the most discussed types of business at the present time is the consumer cooperative. For the first time we have been able to obtain some information which will throw light on the extent to which this type of business has thrived. Likewise, much valuable information will be presented for voluntary chains. It is unfortunate that no facts were collected in the previous censuses by which results may be compared. Observation, however, leads us to believe that there has been a remarkable growth in these types of stores.

Following the type of operation information we shall present commodity sales data, which unfortunately were omitted from the 1933 census. We have collected sales for approximately 200 commodities from more than 100,000 establishments doing a business of $50,000 or more. The answers to the commodity inquiry are necessarily not consistent in all reports. We feel, however, that there is a sufficient number of reports giving reasonably accurate information from which we shall be able to prepare tables which will give an index of commodity sales by kinds of business by states and for principal cities. This is one of the most difficult and complex tabulations being undertaken as a part of the Census of Business, and the information will not be available until sometime in the spring.

The officials of the Bureau of the Census are aware of the fact that we still have a long way to go in developing the technique of preparing and presenting the statistics of business. The success of a business census depends, to a large extent, upon the proper enumeration of the establishments. This is the most difficult problem facing the Bureau. The scope of a Business Census is so complex that it is difficult even for the Bureau staff, which has charge of and is responsible for the job, to fully comprehend its problems. In preparing instructions for the field agents who collect the information, it seems impossible to condense them to less than approximately 100 pages of printed material. Many of the explanations are necessarily technical and difficult for the average field agent to understand. The Census of Business for 1935 being of such a comprehensive nature, the results have not been entirely satisfactory for all of its phases.

It is an easy matter for the field agents to determine in most instances whether an establishment is a retail store, garage, or hotel, but it is frequently impossible for him to determine whether a manufacturer is selling his goods at wholesale through a sales branch, or whether certain types of firms should be included in the Construction or Real Estate Census.

One of the problems which appears to be insurmountable is the contacting of a large number of business concerns which do not have definite, recognizable places of business. This is particularly true in the insurance, real estate, transportation, and construction fields. During recent years a great deal of our residential construction has been carried on by small operators who have no place of business other than their residences. This is more particularly true of subcontractors such as plumbers, electricians, carpenters, and bricklayers. In enumerating trucking for hire we have experienced no difficulty with large transportation companies which own a fleet of trucks. A great deal of the truck transportation, however, is conducted by persons who own one or two trucks and have no place of business other than their homes. These we were unable to enumerate with any degree of accuracy.

We are now convinced that it is not possible to take a complete census of every phase of American business through a single enumeration force. It is my belief that future Censuses of Business should be broken up into smaller sections, retaining in the principal division such businesses as retailers, wholesalers, service establishments, and hotels. The other phases which are included in the present Census should be specialized jobs. For instance, a much more accurate and thorough job would be accomplished on transportation if an enumera-

tor, who was employed in the city for the purpose of collecting such information, had nothing to concern him other than making a thorough survey of that field. This likewise applies to the insurance and real estate field, construction, and professions (which were dropped from this census in its early stages) and other special types of business such as advertising agencies and the operation of commercial and other non-residential buildings.

Breaking the census into smaller sections alone, however, would not solve all our problems. There must be a more adequate central control of the canvass for every phase of American business. The temporary nature of the work makes it impossible to obtain a large number of enumerators for two consecutive censuses. Therefore, in using this method there is a lack of uniformity in the canvass. In the censuses of 1929 and 1933 an enumerator was assigned to a district which contained approximately 100 to 500 businesses coming within the scope of the census. He was furnished no lists whatever, but was instructed to call on each establishment in his district and obtain a report, or explain to his supervisor why the report was not obtained on his first call. There was some improvement in the method used in the 1935 census. Index cards were furnished the enumerators for all retail trade establishments doing a business of $20,000 and over. Owing, however, to the rush of work in connection with the editing, coding and otherwise preparing the schedules for tabulation, it has not been possible for the office to have a sufficient staff to make a thorough check of the enumerators' work by districts. It is believed, however, that this census includes more than 95 per cent of the total businesses of the country falling within its scope. Our objective is to obtain 100 per cent, and any letting down in this respect would soon result in the canvass deteriorating to such an extent that a very much larger percentage of the total business would be lost from the tabulations.

With this in mind, the Business Census Division is now preparing a complete card index of all retail and wholesale trade and service establishments for which reports were obtained in the 1935 census. A master card has been prepared on which will be entered such basic facts as sales, employment, pay rolls and expenses for each census year. We will also include on this card the classification of the establishments for the various censuses which will give us an excellent opportunity to make special studies of the reasons why trends from one kind of business to another are not uniform. This record will provide a permanent history of all business concerns.

It is the policy of the office to classify an establishment in the kind of business represented by the major portion of sales or revenue. For example, many of the principal retail hardware stores are also engaged in wholesaling. If the wholesale operations exceed the retail operations, it is our policy to include that concern in the Wholesale Census. When the next census is taken, the reverse may be true and the same establishment would be tabulated in the Retail Census, thereby showing an unwarranted decrease in wholesale hardware trade with a resultant overstatement of retail trade. This is true of many kinds of business, such as lumber yards, automobile establishments where the establishment acts in the dual capacity of distributor and dealer, and the hay, grain, and feed business.

A card record is also desirable owing to the so-called "hair-line" decisions which must be made in classifying those dual-line establishments which might take either of two kind-of-business classifications. This is particularly true of stores selling such combinations of lines as furniture and hardware, groceries and feed, clothing and general merchandise, or coal and building materials.

Heretofore, census data have been published for cities as a whole. With minor exceptions, no information has been presented for shopping or neighborhood districts within cities such as Chicago, New York, and Philadelphia. There has been, however, since the first complete Census of Distribution in 1929, considerable pressure from various sources for a more detailed breakdown of the retail trade information for areas within the principal cities. The Bureau has not had, until the present time, the facilities for making a comprehensive study of the most practical methods of presenting such data. The 1933 census was taken and completed in a very short time with inadequate funds and it was, therefore, impossible at that time to make a study of this problem. For the past several months the Business Census Division has been making such a study.

The real problem is to determine a suitable business area layout and to make sure that the business data desired for marketing purposes can be compiled and published for these areas without disclosing the operations of individual concerns. Consideration was first given to a plan for dividing the entire city into large communities by combining previously established population census tracts. This method was subject to the objection that in many instances the principal business streets serve as boundaries for the census tracts; hence, combining tracts might split the business centers. The plan would permit a study of retail trade for more or less homogeneous population areas

but it would not afford an analysis of important concentrations of business. Also, community areas arrived at in this manner would include residential and other sections not devoted to or zoned for business uses. Statistics for the large area would not sufficiently localize certain kinds of business to be of maximum value for sales promotion and market analysis. For this purpose it would be necessary to show tabulations for centers or thoroughfares within the larger areas.

Attention was next given to a study of the principal thoroughfares. It is characteristic of most cities that a large portion of the retail stores are located along a few principal streets; in Philadelphia, for example, along Broad Street or Chesnut and Market Streets. Studies show, however, that although business tends to front on the principal streets, particularly at the intersection of transportation arteries, a substantial volume of business is done on cross or parallel streets. Consequently, retail tabulations for principal thoroughfares or segments thereof alone would not furnish adequate information.

Each large city possesses a more or less well defined central business district, which is avoided by through traffic, where space is at a premium, and where buildings grow skyward. This district constitutes the principal shopping center and within its confines is conducted a large portion of the retail trade of the city; hence, an analysis of this district by kind of business is highly desirable.

Within each city there are, in addition to the central business district, a number of more or less well defined outlying business centers. In these centers, as a rule, will be found a predominance of stores that specialize in shopping goods with an important addition of convenience goods business. The latter will not be found to any great extent in the central business district. Any intra-city study not providing for these outlying centers would be incomplete.

There are also special features of each city that would not be brought out by the grouping of census tracts, by studying segments of business thoroughfares or by analyzing the business centers. For instance, one of the most individual chacteristics of Philadelphia is the business done on South Street. Here for 10 or 12 blocks one finds a large number of stores, practically all of which are selling distress merchandise, rejected or discontinued styles. Therefore, statistics which would not segregate data for this market would not furnish to the manufacturer and distributor of merchandise a true picture.

Our experiments indicate that the most satisfactory method of making an intra-city study is first to tabulate the business of the large

community areas comprised of census tracts. These data must be supplemented by tabulations for the central business district, for outlying business centers, and for segments of principal business thoroughfares. Special attention must also be given to any peculiar characteristics of the city. We have, following this method, made experimental tabulations of the 1935 retail trade reports for the City of Philadelphia. We are pleased with the results of this work to date but we do not consider the job finished and solicit your suggestions.

It was not until fifteen or twenty years ago that marketing research came to the fore and was recognized as essential not only in marketing but in gauging production and consumption. In the past, therefore, it was not so essential that the Census reports covering the various subjects be published with as much promptness as is demanded today. Neither was it necessary for these reports to have as widespread distribution, as they were looked upon more as a history than as furnishing valuable up-to-the-minute marketing information. The Bureau of the Census recognizes the fact that the earlier reports are published, the more valuable they are. The information for some purposes is highly perishable. With this in view, we are constantly striving to advance as much as possible, the date on which the information becomes available. Development of a better technique in the collection of the information, of which I have already spoken, must necessarily give adequate consideration to reducing materially the time required to obtain the information.

I think you will agree with me that we have made rapid strides in this direction in compiling the information for the 1935 census, when I tell you that the data contained in the two Retail Trade volumes, totalling 516 pages, that were published on December 15, were produced between the dates of October 29, when the field work was completed, and the date on which they were issued. Normally this process would require five or six months. One of the principal features in producing a report so quickly is the fact that the entire operation, including the printing, is carried on in the Philadelphia office. We do not claim all the credit for producing the report so promptly. It has been brought about partly by business concerns, particularly research agencies, who have told us that the value of the report would materially depreciate unless it were published prior to January 1, 1937. All reports for the 1935 Census of Business, except so-called special studies, will be published on or before June 1, 1937. We have gone a long way, therefore, in developing new means of compiling and publishing the results promptly; the principal problem still remaining, of

which I have spoken before, is the shortening of the time required for collecting the information. This, I assure you, is receiving adequate consideration on the part of all officials of the Bureau of the Census and in the future we hope to improve the 1935 record by four months.

While discussion of the personnel engaged in the 1935 census may not be appropriate on this occasion, I cannot refrain from giving you a brief picture of the splendid results that have been obtained in an organization which is comprised almost 100 per cent of employees taken from relief rolls. As you are undoubtedly aware, the funds for this census were allotted from the Works Progress Administration appropriation with the understanding that not less than 90 per cent of all persons must be taken from the public relief rolls. These employees work under the same regulations as persons in the regular Civil Service positions of the government.

Today we have in the Philadelphia office approximately 1000 relief employees of whom more than 700 are thoroughly capable. We have been able to train more than 300 card-punch and tabulating machine operators who, I believe, can successfully compete with any similar group in the United States. We have also developed supervisory employees and a large number of typists and clerks. The 1935 Census of Business has, therefore, accomplished a two-fold purpose. It has better equipped several hundred persons to carry on their life work and make an independent living in the future. The claim that these people are qualified to go back into private employment is fully substantiated by the fact that more than 100 have already been so employed. It has also accomplished the purpose of supplying much needed marketing information and recorded for history the degree to which United States business was able to come out of the depression within a two-year period. Either of these accomplishments is, I believe, well worth the $7,500,000 that will have been expended when the project is completed.

VARIATIONS IN PRICE RELATIVE DISTRIBUTIONS, JANUARY 1927 TO DECEMBER 1936

By Leonard Ascher
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THE CHANGES in average prices which have occurred in the past few years have been accompanied by drastic alterations in the frequency distributions of price relatives. So revolutionary has been the effect upon these distributions that many of the generalizations previously made concerning the behavior of price relatives are seriously impaired, if not discredited. In support of this contention the distributions for each month, July 1927 to December 1936, are offered here, together with descriptive measures calculated from them.[1]

In the past considerable interest has been shown in this matter of price distribution, with the consequence that several studies have appeared on the subject.[2] From these and other studies certain conclusions have emerged which, in the light of new data, deserve reexamination.

Early investigations of the distribution of prices were animated by the desire to find the mean most appropriate to describe the central tendency. Francis Y. Edgeworth calculated price relatives for twelve commodities covering the years 1782–1820 and 1820–1865, combining them all into one series which was shown by a frequency curve published in his report. This frequency series was positively skew. In his opinion the geometric mean would give the most satisfactory description of such a series.[3] Using a method similar to Edgeworth's, Wesley C. Mitchell arrived at the same conclusion concerning the nature of

[1] Data were secured from United States Bureau of Labor Statistics, *Wholesale Prices*, Washington, 1923–1936. No attempt was made to fill in the gaps which appear in these figures, consequently the number of price relatives in the monthly distributions varies; furthermore, the Bureau has from time to time increased the number of price quotations. However, it does not appear that these defects in the data have influenced the distributions in such a manner that the conclusions presented here are invalid.

[2] Any discussion of price statistics must begin by referring to the comprehensive work of Frederick C. Mills, *The Behavior of Prices*, National Bureau of Economic Research, New York, 1927. Professor Mills analyzes the data available in 1927, and reviews the literature on the subject as well, thus providing a most useful summary of the work already done and giving invaluable bibliographical guidance. Another basic work in this field is that of Wesley C. Mitchell, *The Making and Using of Index Numbers*, Bulletin No. 284, United States Bureau of Labor Statistics, Washington, 1921. See also Maurice Olivier *Les Nombres Indices de la Variation des Prix*, Marcel Giard, Paris, 1927. No important study of price dispersion has appeared since 1927, and therefore the consequences of changing the base of the U.S.-B.L.S. price relatives from 1913 to 1926 have not been shown, nor have the effects of the recent depression on price relative dispersion been pointed out.

[3] Memorandum by the Secretary, appended to the "Report of the Committee Appointed for the Purpose of Investigating the Best Methods of Ascertaining and Measuring Variations in the Value of the Monetary Standard," in the *Report of the British Association for the Advancement of Science*, London, 1887, pp. 254–301, particularly p. 284. However, cf. *idem.*, pp. 286 f.

the distribution of relative prices. He employed 5,578 observations of chain relatives covering a number of years and found a series which was positively skew.[4] This led him to assert:

> For the geometric mean two merits are claimed. First unlike the arithmetic mean, it is not in danger of distortion from the asymmetrical distribution of price fluctuations. Chart 2 shows that in a large collection of percentage variations from the prices of the preceding year, the extreme cases of rise run about twice as far up the scale as the extreme cases of fall run down. *Such a distribution is characteristic of relative prices in general* [italics mine]. Indeed, the case cited is distinctly moderate; most collections of variations covering many years would show a greater difference.[5]

Mitchell's conclusions are open to objection. Like Edgeworth, he combined the figures covering a number of years into one distribution. This procedure tends to obscure the month to month, or year to year, fluctuations. Yet on the basis of this composite distribution Mitchell implies that for any given period price ratios form positively skew distributions, a conclusion which gives support to advocates of the geometric mean. An examination of the monthly data for the period 1927–1936, reveals a large proportion of negatively skewed series for which the geometric mean would give results greatly at variance with the modal or median values. In fact, if the price relatives for the period January 1930 to December 1935 (1926=100) are combined into one series, the consolidated distribution exhibits negative skewness. It therefore appears that Mitchell's findings should be qualified to apply only to a limited period. Furthermore, although the geometric mean may be properly employed to average price relatives, the justification for the use of this measure will not be found in the shape of the price relative distribution.[6]

Another subject of extensive investigation has been the tendency of price data to disperse. Much has been made of this feature because change in dispersion is symptomatic of disturbance of relationships within the price structure; furthermore the validity of an average is affected by the degree of dispersion. It is therefore of interest to note the relatively slight variations in the standard deviation, while the logarithmic measure, which Mills has called the index of dispersion, has shown a higher range of fluctuation.[7] Although the geometric

[4] Mitchell, *ibid.*, p. 18. Another study by him presents distributions for each year, 1913 to 1918. See *History of Prices During the War*, War Industries Board, Bulletin No. 1, Washington 1919.

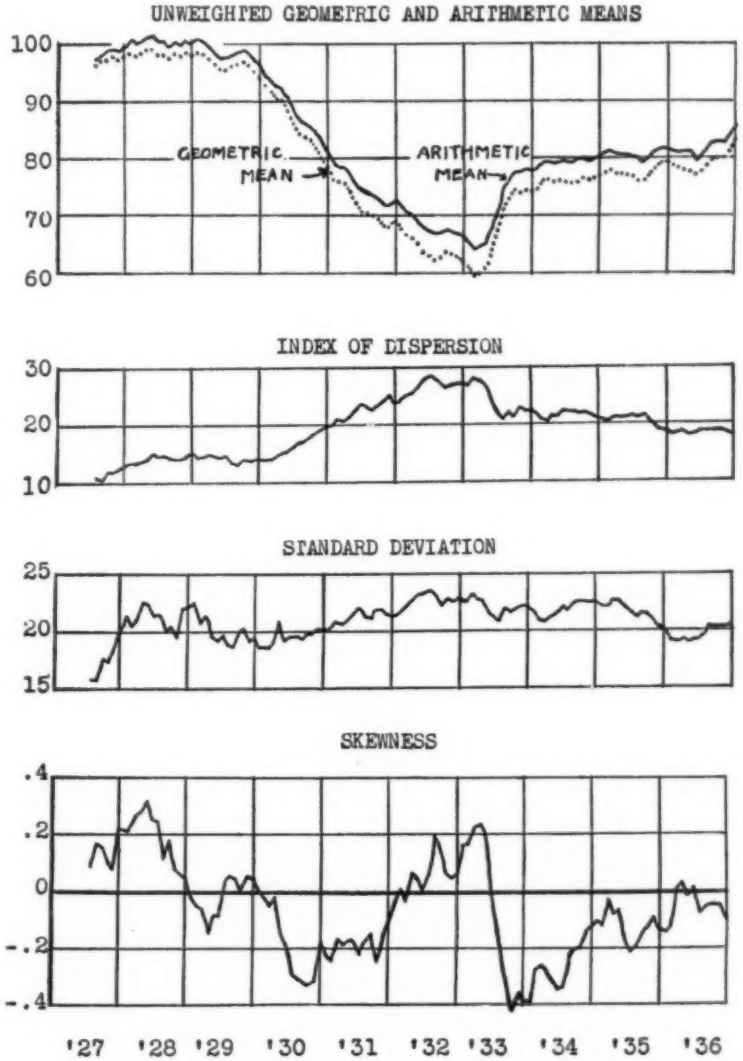
[5] Mitchell, *Making and Using of Index Numbers*, p. 69.

[6] Olivier could find in the nature of the price distributions he examined no clear justification for the use of the geometric mean. *Ibid.*, pp. 79–154; cf. particularly pp. 150–154 for his conclusions.

[7] The index of dispersion was calculated according to the formula given by Mills, *ibid.*, p. 257. The logarithmic standard deviation employed in this calculation was obtained from the organized frequency distributions, employing the logarithms of the midpoints to represent the items contained within each class.

mean is the logical choice for averaging percentages, and the index of dispersion is an appropriate measure of deviation to use in conjunction with it, the extreme changes registered by this measure of dispersion

MEASURES CALCULATED FROM PRICE RELATIVE DISTRIBUTIONS
JULY 1927–DECEMBER 1936
1926 = 100



suggest a qualification to consider when the geometric mean is employed to represent the central tendency of the distributions presented here.

TABLE I
MEASURES CALCULATED FROM FREQUENCY DISTRIBUTIONS OF PRICE RELATIVES, JULY 1927 TO DECEMBER 1936*

	A.M.	G.M.	S.D.	I.D.	Sk.		A.M.	G.M.	S.D.	I.D.	Sk.
1927						1932					
Jan.	—	—	—	—	—	Jan.	71.2	67.4	21.6	24.2	−.034
Feb.	—	—	—	—	—	Feb.	70.4	66.5	22.0	25.2	+.004
Mar.	—	—	—	—	—	Mar.	70.0	65.9	22.5	25.9	−.037
Apr.	—	—	—	—	—	Apr.	69.3	65.0	23.1	26.4	+.065
May	—	—	—	—	—	May	68.1	63.5	23.2	27.6	+.045
June	—	—	—	—	—	June	67.4	62.6	23.4	28.3	+.010
July	97.3	96.1	15.8	10.9	+.088	July	66.7	62.1	23.5	28.0	+.060
Aug.	98.2	97.0	15.7	10.5	+.164	Aug.	66.9	62.5	23.0	27.4	+.195
Sept.	98.9	97.4	17.6	11.7	+.148	Sept.	67.6	63.4	22.3	26.2	+.170
Oct.	99.1	97.7	17.4	11.8	+.103	Oct.	67.2	63.0	22.8	26.6	+.067
Nov.	99.1	97.4	18.6	12.6	+.081	Nov.	67.0	62.6	22.7	27.1	+.057
Dec.	99.7	97.9	19.8	13.0	+.221	Dec.	66.2	61.8	22.8	27.4	+.066
1928						1933					
Jan.	100.3	98.4	21.4	13.3	+.216	Jan.	65.1	60.8	22.7	27.3	+.166
Feb.	100.0	98.0	20.6	13.3	+.215	Feb.	64.0	59.4	23.2	28.3	+.168
Mar.	100.5	98.4	21.2	13.7	+.255	Mar.	64.2	59.8	22.9	27.7	+.226
Apr.	101.2	99.0	22.5	14.2	+.269	Apr.	64.9	60.6	22.6	27.1	+.235
May	101.6	99.1	23.3	15.1	+.314	May	67.5	63.9	21.8	24.2	+.198
June	100.2	98.0	21.4	14.8	+.252	June	70.5	67.1	21.4	22.3	+.015
July	100.3	98.0	21.3	14.8	+.240	July	74.5	71.4	20.9	21.0	−.118
Aug.	99.6	97.6	20.0	14.3	+.109	Aug.	76.2	72.7	22.0	22.2	−.221
Sept.	100.4	98.3	20.4	14.2	+.176	Sept.	77.6	74.2	21.6	21.7	−.332
Oct.	100.1	98.1	19.4	14.3	+.077	Oct.	77.4	73.7	22.0	22.7	−.415
Nov.	100.8	98.5	22.0	14.6	+.060	Nov.	77.8	74.2	22.2	22.4	−.359
Dec.	100.6	98.2	22.2	15.2	+.043	Dec.	77.7	74.0	22.3	22.5	−.384
1929						1934					
Jan.	100.8	98.6	22.4	14.5	−.005	Jan.	78.2	74.7	21.6	22.0	−.393
Feb.	100.3	98.2	20.7	14.5	−.041	Feb.	79.1	76.0	21.0	20.7	−.281
Mar.	99.8	97.5	21.2	14.9	−.061	Mar.	79.3	76.2	20.9	20.5	−.262
Apr.	98.6	96.4	19.6	14.7	−.141	Apr.	79.0	75.7	21.2	21.3	−.286
May	97.5	95.5	19.3	14.2	−.081	May	79.3	75.9	21.6	21.5	−.305
June	97.5	95.5	19.6	14.5	−.081	June	79.4	75.8	22.0	22.3	−.340
July	98.1	96.2	18.8	13.4	+.029	July	79.0	75.5	21.8	22.3	−.334
Aug.	98.5	96.6	18.7	13.3	+.058	Aug.	79.5	75.9	22.4	22.1	−.229
Sept.	98.9	96.9	19.9	13.8	+.048	Sept.	79.9	76.4	22.6	22.1	−.201
Oct.	98.3	96.3	20.2	13.9	.000	Oct.	79.6	76.1	22.5	22.1	−.196
Nov.	97.0	95.1	19.2	13.9	+.055	Nov.	79.6	76.2	22.5	21.7	−.140
Dec.	96.2	94.1	19.5	14.2	+.054	Dec.	80.1	76.7	22.7	21.4	−.122
1930						1935					
Jan.	94.7	92.8	18.5	14.2	.000	Jan.	80.6	77.4	22.2	20.6	−.103
Feb.	93.5	91.6	18.5	14.2	−.013	Feb.	81.1	77.8	22.2	20.7	−.115
Mar.	92.1	90.1	19.0	14.6	−.056	Mar.	80.6	77.3	22.6	21.2	−.025
Apr.	92.2	90.0	20.8	15.2	−.015	Apr.	80.6	77.3	22.7	21.1	−.078
May	90.6	88.4	19.3	15.6	−.158	May	80.5	77.1	22.2	21.1	−.068
June	88.8	86.1	19.4	16.3	−.222	June	80.2	76.9	21.6	21.3	−.172
July	86.7	84.3	19.5	17.1	−.292	July	79.4	76.1	21.2	21.2	−.214
Aug.	86.3	83.8	19.4	17.3	−.310	Aug.	79.7	76.3	21.4	21.5	−.196
Sept.	85.8	83.1	19.8	18.5	−.328	Sept.	80.6	77.4	21.4	20.3	−.145
Oct.	84.7	81.9	19.8	18.8	−.327	Oct.	81.3	78.3	21.0	19.6	−.131
Nov.	82.8	79.9	20.2	19.6	−.315	Nov.	81.9	79.1	20.1	18.9	−.091
Dec.	81.5	78.5	20.2	19.8	−.178	Dec.	81.9	79.2	20.0	18.8	−.140
1931						1936					
Jan.	79.5	76.0	20.2	20.0	−.222	Jan.	81.4	78.9	19.1	18.2	−.140
Feb.	78.4	75.8	20.8	21.0	−.249	Feb.	81.1	78.5	19.1	18.3	−.126
Mar.	78.2	75.1	20.6	20.7	−.163	Mar.	80.3	77.7	19.2	18.5	+.005
Apr.	77.1	73.9	20.8	21.4	−.188	Apr.	80.3	77.7	19.1	18.3	+.030
May	75.5	72.0	21.6	22.5	−.178	May	79.7	77.1	19.1	18.4	−.005
June	74.4	70.7	22.0	23.5	−.191	June	80.2	77.6	19.1	18.4	+.006
July	73.9	70.3	21.3	23.1	−.226	July	81.6	78.9	19.5	18.8	−.069
Aug.	73.6	70.0	21.2	22.8	−.180	Aug.	82.6	79.8	20.2	18.8	−.056
Sept.	72.9	69.2	21.8	23.6	−.151	Sept.	82.8	80.1	20.2	18.8	−.045
Oct.	71.9	68.1	21.9	24.2	−.260	Oct.	83.0	80.2	20.2	18.8	−.050
Nov.	71.9	68.0	21.4	25.2	−.153	Nov.	83.9	81.3	20.2	18.1	−.052
Dec.	72.7	69.0	21.3	23.9	−.100	Dec.	85.8	83.1	20.4	18.0	−.087

* A.M. Arithmetic Mean
G.M. Geometric Mean
S.D. Standard Deviation
I.D. Index of Dispersion (See Mills, *ibid.*, p. 257)
Sk. Skewness $=3$ (A.M. $-$Mean)/σ

TABLE II

FREQUENCY DISTRIBUTIONS OF RELATIVE WHOLESALE PRICES†

July 1927 to December 1936

Relative	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1927												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	—	—	—	—	—	—	—	—	—	—
20.0– 29.9	—	—	—	—	—	—	—	—	—	—	—	—
30.0– 39.9	—	—	—	—	—	—	—	—	—	—	—	—
40.0– 49.9	—	—	—	—	—	—	2	1	1	1	2	1
50.0– 59.9	—	—	—	—	—	—	2	2	6	7	7	9
60.0– 69.9	—	—	—	—	—	—	17	13	15	12	18	17
70.0– 79.9	—	—	—	—	—	—	30	31	28	33	36	32
80.0– 89.9	—	—	—	—	—	—	82	79	81	79	69	74
90.0– 99.9	—	—	—	—	—	—	192	191	167	157	156	162
100.0–109.9	—	—	—	—	—	—	146	146	142	145	148	131
110.0–119.9	—	—	—	—	—	—	25	32	46	51	47	53
120.0–129.9	—	—	—	—	—	—	15	16	26	27	25	26
130.0–139.9	—	—	—	—	—	—	9	8	8	8	8	10
140.0–149.9	—	—	—	—	—	—	3	6	5	5	7	8
150.0–159.9	—	—	—	—	—	—	3	4	3	2	3	3
160.0–169.9	—	—	—	—	—	—	1	—	—	2	2	3
170.0–179.9	—	—	—	—	—	—	1	1	—	—	2	2
180.0–189.9	—	—	—	—	—	—	1	1	2	1	1	1
190.0–199.9	—	—	—	—	—	—	—	—	—	—	—	1
200.0–209.9	—	—	—	—	—	—	—	—	—	—	1	—
210.0–219.9	—	—	—	—	—	—	—	—	—	1	—	—
220.0–229.9	—	—	—	—	—	—	—	—	—	—	—	—
230.0–239.9	—	—	—	—	—	—	—	—	1	—	—	1
1928												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	—	—	—	—	—	—	—	—	—	—
20.0– 29.9	—	—	—	—	—	1	—	1	—	1	—	—
30.0– 39.9	—	—	—	—	1	2	4	3	4	3	4	6
40.0– 49.9	1	—	1	2	3	3	2	1	1	1	2	2
50.0– 59.9	7	7	8	6	10	5	8	8	9	10	6	5
60.0– 69.9	21	26	22	22	13	14	11	11	9	7	13	13
70.0– 79.9	26	29	32	31	30	31	26	32	29	31	36	36
80.0– 89.9	71	66	69	70	75	81	87	80	72	76	72	74
90.0– 99.9	159	163	155	147	149	152	145	146	154	141	127	128
100.0–109.9	154	150	136	151	145	142	141	153	151	153	151	152
110.0–119.9	37	32	49	36	37	35	40	44	49	47	66	66
120.0–129.9	21	23	22	21	21	21	19	20	13	21	15	15
130.0–139.9	11	12	13	16	20	18	15	11	16	15	14	14
140.0–149.9	10	11	10	9	9	7	12	8	9	15	15	15
150.0–159.9	4	6	7	12	11	9	6	7	4	5	3	3
160.0–169.9	2	1	5	—	2	4	4	3	6	2	2	2
170.0–179.9	4	3	1	3	3	—	2	1	2	—	—	—
180.0–189.9	1	2	1	3	2	—	1	1	1	—	3	3
190.0–199.9	1	—	—	1	1	4	3	2	2	1	1	1
200.0–209.9	1	1	2	1	1	1	—	—	—	—	—	—
210.0–219.9	—	—	1	1	2	—	—	—	—	—	—	—
220.0–229.9	—	1	—	1	1	—	—	—	—	—	—	—
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
270.0–279.9	1	—	—	—	—	—	—	—	—	—	—	—
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
300.0–309.9	—	—	—	—	—	—	—	—	—	—	1	1
1929												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	—	—	—	—	—	—	—	—	—	—
20.0– 29.9	—	1	1	1	1	1	—	—	—	—	—	—
30.0– 39.9	2	2	2	2	—	2	—	1	1	1	4	4
40.0– 49.9	5	4	2	4	6	3	4	3	3	2	—	1
50.0– 59.9	6	7	12	10	8	8	10	8	8	8	7	7
60.0– 69.9	12	15	17	17	20	21	23	19	21	23	21	30
70.0– 79.9	40	30	28	36	42	41	26	29	30	44	50	48
80.0– 89.9	66	72	79	76	76	79	80	80	82	78	88	88
90.0– 99.9	122	127	120	124	139	135	151	151	137	129	148	150
100.0–109.9	160	150	151	159	154	157	144	149	151	146	133	119
110.0–119.9	63	71	63	49	42	38	42	34	37	42	40	39
120.0–129.9	22	31	23	17	17	17	16	19	21	22	18	18
130.0–139.9	17	10	12	18	8	10	14	16	20	19	18	13
140.0–149.9	13	7	11	8	7	3	7	8	8	7	5	10
150.0–159.9	1	2	2	3	5	6	4	3	1	—	2	2
160.0–169.9	—	—	—	—	1	3	1	1	1	1	1	—

(*1929 continued on next page*)

TABLE II (*Continued*)

Relative	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
170.0–179.9	—	—	1	1	1	1	2	1	—	1	—	—
180.0–189.9	1	1	2	1	1	1	1	2	3	2	2	1
190.0–199.9	3	2	—	1	1	1	—	—	—	—	—	2
200.0–209.9	—	1	1	—	—	—	—	—	—	—	1	—
210.0–219.9	—	—	—	—	—	—	—	—	—	—	—	—
220.0 229.9	—	—	—	—	—	—	—	—	—	—	—	—
230.0–239.9	—	—	—	—		—	—	—	1	—	—	—
240.0–249.9	—	—	—	—	—	—	—	—	—	—	—	—
250.0–259.9	—	1	—	—	—	—	—	—	—	1	—	—
260.0–269.9	—	—	1	—	—	—	—	—	—	—	—	—
...	...	...	...	...	...	...	...	...	...	...	...	...
330.0–339.9	1	—	—	—	—	—	—	—	—	—	—	—
1930												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	—	—	—	—	—	—	3	3	3	3
20.0– 29.9	1	—	—	1	3	3	3	3	—	—	1	1
30.0– 39.9	3	4	4	3	1	2	1	2	3	1	3	6
40.0– 49.9	1	2	2	3	6	6	21	20	19	23	25	27
50.0– 59.9	12	15	15	11	13	18	19	23	29	42	51	51
60.0– 69.9	22	20	40	44	49	62	60	59	57	48	49	51
70.0– 79.9	53	64	62	59	68	74	69	66	67	70	81	109
80.0– 89.9	111	116	112	115	109	104	114	115	115	120	114	104
90.0– 99.9	146	143	144	150	145	135	133	128	130	124	108	108
100.0–109.9	117	115	99	93	103	94	88	88	84	77	78	66
110.0–119.9	45	33	31	32	19	24	18	19	17	17	17	17
120.0–129.9	12	14	17	14	12	10	8	8	11	10	6	4
130.0–139.9	13	10	10	10	11	7	5	4	1	1	1	3
140.0–149.9	5	4	3	1	—	1	—	—	1	—	—	—
150.0–159.9	1	2	1	2	2	—	2	1	1	1	—	—
160.0–169.9	—	—	—	—	1	2	—	—	—	—	—	—
170.0–179.9	—	—	—	—	—	2	—	—	—	—	—	—
180.0–189.9	—	—	—	—	1	—	—	—	—	—	—	—
190.0–199.9	2	2	2	2	1	—	1	1	1	1	1	1
200.0–209.9	—	—	—	—	—	—	—	—	—	—	—	—
...	...	...	...	...	...	...	...	...	...	...	...	...
300.0–309.9	—	—	—	1	—	—	—	—	—	—	—	—
1931												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	2	2
10.0– 19.9	3	3	3	3	4	5	4	3	3	3	2	1
20.0– 29.9	1	1	1	4	5	4	5	4	7	9	6	9
30.0– 39.9	6	14	15	14	13	19	23	28	29	30	26	40
40.0– 49.9	32	32	28	26	37	45	44	47	48	59	56	67
50.0– 59.9	52	59	54	73	86	84	75	61	65	64	67	82
60.0– 69.9	73	67	79	70	64	61	71	86	81	66	82	134
70.0– 79.9	92	94	98	95	91	93	89	86	95	101	91	128
80.0– 89.9	113	110	104	103	102	95	105	102	95	96	96	133
90.0– 99.9	91	88	91	86	78	73	67	72	66	59	60	95
100.0–109.9	61	57	55	53	48	50	50	42	43	44	40	51
110.0–119.9	9	11	8	7	8	7	5	7	7	5	7	11
120.0–129.9	4	2	3	1	1	3	2	1	1	1	1	1
130.0–139.9	2	2	2	4	3	1	1	1	—	1	—	—
140.0–149.9	1	1	1	—	1	1	—	—	—	—	—	—
150.0–159.9	—	—	—	—	—	—	—	—	—	—	—	—
160.0–169.9	—	—	—	—	—	—	1	—	—	—	—	1
170.0–179.9	—	—	—	—	—	—	—	1	2	1	1	—
180.0–189.9	—	—	—	—	—	—	—	—	—	—	—	—
190.0–199.9	1	1	1	1	1	1	—	—	—	—	—	1
1932												
0.0– 9.9	2	3	3	3	3	3	3	4	3	3	3	3
10.0– 19.9	1	1	1	—	1	3	2	—	1	—	—	—
20.0– 29.9	8	7	10	16	26	25	23	21	15	21	25	28
30.0– 39.9	47	47	55	51	55	70	71	54	57	60	64	71
40.0– 49.9	67	85	81	108	106	96	111	117	100	104	91	94
50.0– 59.9	117	112	111	93	100	100	106	126	126	109	123	120
60.0– 69.9	117	118	112	123	114	112	101	103	122	124	111	113
70.0– 79.9	129	122	124	105	97	100	106	99	107	118	112	111
80.0– 89.9	114	112	109	111	117	114	108	105	101	101	109	107
90.0– 99.9	93	91	91	92	84	79	73	73	74	70	72	68
100.0–109.9	43	40	40	41	40	41	38	39	37	35	34	34
110.0–119.9	12	13	12	11	13	10	12	12	10	10	10	10
120.0–129.9	1	1	2	1	1	2	2	1	2	2	1	1
130.0–139.9	—	—	—	—	—	—	—	—	—	—	—	—

(*1932 continued on next page*)

TABLE II (*Continued*)

Relative	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
140.0–149.9	—	—	—	1	—	—	—	—	1	—	—	—
150.0–159.9	2	1	1	1	1	1	—	—	—	—	—	—
160.0–169.9	—	1	—	—	—	—	—	—	—	1	—	—
170.0–179.9	—	—	—	—	—	—	—	—	—	—	—	—
180.0–189.9	—	—	1	—	—	—	1	1	1	1	1	1
190.0–199.9	1	1	1	2	1	1	1	1	1	1	1	1
1933												
0.0– 9.9	3	3	3	3	1	—	—	—	—	—	—	—
10.0– 19.9	—	2	2	1	4	4	3	3	3	3	3	2
20.0– 29.9	27	31	24	28	19	7	4	5	5	9	7	8
30.0– 39.9	75	88	82	58	38	42	26	30	24	28	29	28
40.0– 49.9	107	110	124	123	79	66	58	61	53	52	48	67
50.0– 59.9	126	118	121	135	156	116	91	84	82	85	82	64
60.0– 69.9	110	107	103	103	145	144	114	87	92	82	83	83
70.0– 79.9	109	105	110	118	128	156	165	143	125	117	124	123
80.0– 89.9	97	96	91	92	99	117	156	164	177	177	179	171
90.0– 99.9	61	56	57	52	54	65	85	94	108	114	115	121
100.0–109.9	33	33	33	32	32	36	44	65	65	66	63	67
110.0–119.9	10	10	10	10	11	12	15	19	23	21	22	22
120.0–129.9	1	1	1	2	1	1	1	5	4	5	6	5
130.0–139.9	—	—	—	1	1	1	2	1	2	3	4	3
140.0–149.9	—	—	—	—	—	—	—	1	1	3	2	2
150.0–159.9	—	—	—	—	—	—	—	—	—	—	—	—
160.0–169.9	—	—	—	—	—	—	—	—	1	—	—	—
170.0–179.9	—	—	—	—	—	—	—	—	—	—	—	—
180.0–189.9	1	1	1	1	1	1	1	1	1	—	1	1
190.0–199.9	1	1	1	1	1	1	1	2	1	1	1	1
200.0–209.9	—	—	—	—	—	—	—	—	—	—	—	—
210.0–219.9	—	—	—	—	—	—	—	—	—	—	—	—
220.0–229.9	—	—	—	—	—	—	1	—	—	—	—	—
230.0–239.9	—	—	—	—	1	—	—	—	—	—	—	—
240.0–249.9	—	—	—	—	—	1	—	—	—	—	—	—
1934												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	2	1	1	1	1	3	4	4	4	3	1	1
20.0– 29.9	9	9	9	10	11	11	9	8	8	13	14	13
30.0– 39.9	23	15	12	14	17	20	21	22	22	17	18	14
40.0– 49.9	58	42	44	56	50	42	40	35	30	35	36	39
50.0– 59.9	68	86	78	67	73	71	75	67	64	56	59	56
60.0– 69.9	90	89	98	90	87	93	96	108	111	117	105	109
70.0– 79.9	119	127	125	130	123	112	115	122	122	127	142	137
80.0– 89.9	179	172	171	167	164	180	174	163	168	168	167	176
90.0– 99.9	123	123	122	120	130	123	122	127	126	124	117	110
100.0–109.9	70	76	78	81	80	80	80	77	77	73	72	75
110.0–119.9	22	22	22	19	21	21	21	23	21	22	25	24
120.0–129.9	5	7	7	7	9	7	6	6	7	9	6	9
130.0–139.9	5	5	5	5	4	5	4	4	6	3	6	5
140.0–149.9	1	1	1	1	2	3	2	3	2	2	2	4
150.0–159.9	—	—	—	—	—	1	1	—	—	1	1	—
160.0–169.9	—	—	—	—	—	—	—	—	1	—	—	—
170.0–179.9	—	—	—	—	—	—	—	—	—	—	—	1
180.0–189.9	—	—	—	—	—	—	—	—	—	—	—	—
190.0–199.9	1	1	1	1	1	1	1	1	1	1	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...
250.0–259.9	—	—	—	—	—	—	—	1	—	—	—	—
...	...	...	...	...	...	...	...	...	...	...	...	...
270.0–279.9	—	—	—	—	—	—	—	—	1	1	1	1
1935												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	1	—	—	2	1	2	—	—	—	—
20.0– 29.9	12	12	12	14	15	12	13	12	10	9	6	6
30.0– 39.9	13	15	13	12	12	13	19	19	20	16	17	17
40.0– 49.9	39	34	35	36	34	31	29	31	26	25	21	24
50.0– 59.9	51	53	57	54	56	70	71	64	59	48	48	44
60.0– 69.9	99	94	103	113	112	104	102	107	108	123	105	101
70.0– 79.9	147	143	151	135	140	127	135	134	135	129	146	140
80.0– 89.9	178	186	163	177	171	177	174	171	172	169	172	182
90.0– 99.9	110	108	106	102	106	110	113	118	125	136	133	137
100.0–109.9	77	79	78	74	68	68	71	72	71	77	76	71
110.0–119.9	29	31	31	32	33	32	26	25	25	21	27	24
120.0–129.9	7	7	9	10	14	14	11	12	13	12	13	15
130.0–139.9	4	5	8	6	8	6	4	3	4	5	4	4

(*1935 continued on next page*)

TABLE II (*Continued*)

Relative	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
140.0–149.9	4	3	1	2	—	1	1	2	1	1	1	1
150.0–159.9	—	—	—	1	1	1	—	—	—	—	—	1
160.0–169.9	—	—	1	1	—	—	—	1	1	1	1	—
170.0–179.9	—	1	—	—	—	—	—	—	—	—	—	—
180.0–189.9	—	—	—	—	—	—	—	—	—	—	—	—
190.0–199.9	1	1	1	1	1	1	1	1	1	1	1	1
200.0–209.9	—	—	—	—	—	—	—	—	1	—	—	—
210.0–219.9	—	—	—	—	—	—	—	—	—	1	—	—
220.0–229.9	—	—	—	—	—	—	—	—	—	—	—	—
230.0–239.9	—	—	—	—	1	—	—	—	—	—	—	—
...	...	...	...	...	...	...	...	...	...	...	...	...
270.0–279.9	—	1	—	1	—	—	—	—	—	—	—	—
280.0–289.9	1	—	1	—	—	—	—	—	—	—	—	—
1936												
0.0– 9.9	—	—	—	—	—	—	—	—	—	—	—	—
10.0– 19.9	—	—	—	—	—	—	1	1	1	—	—	—
20.0– 29.9	4	6	6	6	7	8	7	6	6	8	2	2
30.0– 39.9	19	16	17	16	14	11	10	9	9	11	17	13
40.0– 49.9	19	21	23	22	24	26	28	26	28	24	18	23
50.0– 59.9	50	50	54	55	47	43	45	49	44	45	51	45
60.0– 69.9	103	105	106	102	144	131	96	88	84	81	75	59
70.0– 79.9	148	153	175	182	153	163	161	151	155	159	149	134
80.0– 89.9	182	181	163	163	162	167	194	196	195	180	176	175
90.0– 99.9	129	126	114	114	115	113	115	128	127	142	152	161
100.0–109.9	75	73	72	70	66	67	68	66	72	70	72	94
110.0–119.9	23	23	22	24	24	23	27	30	33	31	36	37
120.0–129.9	13	12	13	10	8	9	14	14	11	14	13	19
130.0–139.9	2	2	3	4	5	5	7	5	3	4	6	6
140.0–149.9	2	2	1	1	1	2	2	2	5	4	6	6
150.0–159.9	—	—	—	—	—	—	—	1	—	2	1	1
160.0–169.9	—	—	—	—	—	—	—	1	—	—	—	—
170.0–179.9	—	—	—	—	—	—	—	2	3	—	1	—
180.0–189.9	—	—	—	—	—	—	—	—	—	1	—	1

† Taken from United States Bureau of Labor Statistics, Bulletins on Wholesale Prices. Wherever possible data were tabulated from the Bulletin for the month following; e.g., data for July 1929 was taken from the August 1929 Bulletin. However, November 1929 statistics were secured from the publication for the year following. Recently the Bureau has published the data only in the June and December *Bulletins*.

It has been asserted that the rise or fall of average prices has certain effects upon the degree of dispersion. When prices are rising the dispersion is greater; when they fall the price relatives are "squeezed" into a narrower compass and the dispersion is less marked.[8] Mills tested this generalization and concluded that "The results of the present study show that there is a connection between price dispersion and changes in the price level, but there does not appear to be such a simple and direct relation as that suggested by the authorities quoted."[9] The recent data indicate that *if* there is any relation between the degree of dispersion and changes in the price level it is far from being a simple and direct one. In fact an inspection of the charts showing the measures calculated from the monthly distributions for the

[8] Mills, *ibid.*, pp. 279 f., reviews the ideas on this point held by Wesley C. Mitchell, Francis Y. Edgeworth, Norman Crump and Lucien March. Cf. also G. Udny Yule's discussion of A. W. Flux's paper in the *Journal of the Royal Statistical Society*, Vol. LCCCIV (1921), p. 201.

[9] Mills, *ibid.*, p. 280. For a more complete understanding of Mills' position in regard to dispersion of price relatives and the price level, consult his "Post-War Prices and Pre-War Trends," in this JOURNAL, Vol. 23 (March, 1928, Supplement), pp. 45–67.

period following 1930 might lead one to conclude that falling prices mean higher dispersion, and rising price averages bring a closer concentration of price relatives about their means. This is exactly contrary to the thesis mentioned above.

With respect to skewness, there appears to be no consistent tendency. Mitchell's statement that positive skewness is characteristic of price relative series has already been quoted.[10] However, in the distributions for the period following 1927 negative skewness is more common than positive. Irving Fisher has pointed out that there is as much reason for negative as positive skewness, because a positively skewed distribution becomes negative when the base is reversed.[11]

One questionable statement has frequently appeared concerning the skewness of price relative series. It is that such distributions are positively skew because there is no upper limit to the possible rise in prices, but the lower limit of price change is zero. So frequently is this statement encountered in the literature of index numbers that specific citations should be unnecessary. Furthermore, this reasoning is sometimes employed to explain the "geometric" character of price relative series. However, if prices can rise indefinitely, but can fall only to zero, what is to prevent a large number of individual prices from rising, thus putting the bulk of the numbers in the higher values and imparting a negative skewness to the distribution? Furthermore, why should the asserted tendency for prices to rise disproportionately result in a series which will distribute symmetrically if plotted on semi-logarithmic co-ordinate paper? If valid answers to these questions are to be found, one must go behind the price quotations to the forces which affect the movement of prices.

Another contention which cannot survive criticism is that during periods of rising prices skewness tends to be negative, while during price recessions positive skewness is the rule.[12] Mills found no justification for this assertion, and the results of the present study indicate no definite relationship between the direction of skewness and the direction of price changes.[13]

In conclusion, it may be reiterated that very few generalizations concerning the behavior of price relatives can be made with assurance.

[10] See p. 272, *supra*.

[11] *The Making of Index Numbers*, Houghton Mifflin Co., Boston and New York, 3d rev. ed., 1927, pp. 408–410.

[12] Alfred W. Flux, "The Measurement of Price Changes," in the *Journal of the Royal Statistical Society*, Vol. LCCCIV (1921), p. 190, quoted in Mills, *ibid.*, pp. 337 f. G. Udny Yule, in discussing Flux's paper, stated that tabulations which he had made gave symmetrical series except for years of sharply rising prices when positive skewness was found. *Ibid.*, p. 201. Yule's tabulation of Sauerbeck's data are shown in a chart published in the *Statist*, Jan. 26, 1924, p. 115.

[13] The formula used here to describe skewness is $Sk = 3(M - Md)/\sigma$.

This investigation reveals that for the period covered the distributions are bell-shaped, but otherwise they exhibit remarkable aberrations. They appear to follow no rules so far as skewness is concerned, and the dispersion of the price relatives is so greatly at variance with some previous investigations that valid generalizations which will apply to all periods of price history are difficult to find. However, the negative conclusions obtained in this study indicate the necessity of going behind the price statistics to the economic forces which act upon prices to produce such marked variations between distributions.

A GRAPHIC METHOD OF MEASURING SEASONAL VARIATION[1]

By William A. Spurr
University of Nebraska

The methodology of measuring seasonal variation has been improved in recent years by the development of more accurate though elaborate methods, but little has been done toward the simplification of procedure for the purpose of saving labor. The usual task of gauging seasonal movement, however, is extensive rather than intensive, requiring comparative accuracy with a reasonable economy of effort. The solution is necessarily approximate, even when precise methods are used, both because non-seasonal elements are indeterminate and because the weather and customs which produce seasonality are themselves variable.

The writer believes that the seasonal problem may be simplified by substituting graphic measurement for numerical computation in all or some of the steps involved, in order to save time without sacrifice of accuracy. The method described here permits the direct measurement or elimination of the seasonal element of a time series on a chart using no figures, and with only a pencil and several strips of paper as equipment. This device may also be used to eliminate seasonality and trend simultaneously, thus reducing a curve to its cyclical and random elements in one operation. Much time is saved, since computation is eliminated. In the hands of a skilled operator the degree of accuracy approximates that of analogous numerical methods, the errors of graphic estimation being largely or wholly offset by the advantages of the diagram analysis and the averaging process employed.

The procedure may be summarized as follows. First, a non-seasonal base line is drawn on the chart. This may be a trend or trend-cycle curve,[2] or one of the alternatives noted under (2) below. Then (for monthly data) the ratio of each January's actual value to its non-seasonal value, as determined by this line, is measured[3] by marking off the graphic interval on a paper edge, and a geometric mean taken of the central group of all such ratios.[4] This mean, when adjusted to

[1] The writer is indebted to Professor F. C. Mills for criticism and suggestions concerning this method.

[2] Cf. King's "preliminary cycle curve": King, W. I., "An Improved Method for Measuring the Seasonal Factor," This Journal, Vol. 19 (Sept. 1924), pp. 304–307.

[3] Falkner, H. D. "The Measurement of Seasonal Variation," This Journal, Vol. 19 (June 1924), pp. 171–179.

[4] This type of average is somewhat similar to Kuznets' "positional arithmetic mean," but is reached by a different process. Cf. Kuznets, Simon, *Seasonal Variation in Industry and Trade* (New York, 1933), pp. 28, 31–33.

average 100 per cent for the twelve months, represents the January index of seasonal variation. If the January ratios fail to cluster, but tend to drift through the years, a smooth curve is drawn through their plotted values to secure a progressive measure of seasonal variation. The January data may then be corrected either for seasonal variation alone or for seasonal and trend movements together, by marking the appropriate distances on the chart from the paper strips. Other months are treated similarly.

This method may be used in its skeleton form for rough and rapid seasonal measurement, or in more refined form if greater accuracy is required. The optional refinements include greater care in the selection of a base line, adjustment of seasonal indexes to average 100 per cent, the use of diagram charts for each month, and final checking by means of annual calendar charts. Each operation may be altered to fit the needs of a particular case, since graphic expedients may be borrowed from almost any numerical method. Conversely, numerical computation may be sustituted for any graphic step which appears faulty.

The procedure involves five steps:

(1) The series is plotted on semi-logarithmic paper. The use of this scale implies two assumptions: first, that seasonal variation tends to be more stable as a ratio than as an absolute amount; and second, that the use of ratios is preferable to that of absolute quantities in its computation.[5] In case the reverse is found to be true, arithmetic paper may be used instead.

(2) A smooth line of central tendency is fitted to the series. This may be:

(a) A trend line of any type, either drawn free-hand or mathematically fitted by least squares. The latter is more laborious but more accurate than the former.

(b) A free-hand "trend-cycle" curve (resembling a smoothed twelve-month moving average) following not only the trend but also cyclical and random movements of more than a year's duration. The fitting of this curve involves a subjective error,[6] but its use

[5] Hall, L. W. "Seasonal Variation as a Relative of Secular Trend," This JOURNAL, Vol. 19 (June 1924), pp. 156–166.

[6] This error cancels out either if the average level of the free-hand curve is too high or too low (since the seasonal indexes are adjusted to average 100 per cent), or if its positive and negative errors are equal (since the ratios for each month are averaged). The residual error may be minimized by: (1) breaking the trend-cycle curve at points of abrupt change, omitting erratic months; and (2) adjusting so that the areas formed above and below the curve appear equal in each year.

The moving average itself often involves a large error, since it fails to reach the peaks, valleys, and extremities of a series, and, unlike the free-hand curve, distorts the 11 or 12 months adjacent to a point of abrupt change. The Federal Reserve Board now uses the free-hand curve for industries showing abrupt non-seasonal shifts (*Federal Reserve Bulletin*, Dec. 1936), but checks this curve against a twelve-month moving average. The use of a free-hand curve alone is of course less precise than the use of both curves, but saves much labor.

as a base removes most of the cyclical distortion from the monthly seasonal relatives. The trend-cycle curve is therefore preferable to the trend line if the cyclical movement of a series is pronounced.

While the use of a trend or trend-cycle curve is assumed in the following discussion for the sake of simplicity, certain alternatives may be used instead:

(c) Horizontal lines representing annual averages.

(d) Horizontal lines drawn at the average level of complete cycles.

(e) Any horizontal line on the chart. (This corresponds to the method of absolute monthly means.)

(f) A graphic application of the link-relative method, described in footnote 9, which obviates the use of any such line.

The choice of a base line depends on the same critieria as in corresponding numerical methods. The most accurate base is that which best portrays the non-seasonal elements of the data.

(3) A strip of paper, roughly bisected by a dotted or colored line, is placed vertically on the chart with its edge on the January point of the first year, and its dotted line on the line of central tendency, as shown in Figure 1. The January position is then marked on the edge of the paper strip, as shown by the arrow. The same is done with the other Januaries, the dotted line being placed in each case on the line of central tendency. Now examine the strip (Figure 2) horizontally. The linear distance from each point to the dotted origin represents the ratio of a January value to its "normal" value. The numerical magnitude of the ratio can be read directly from the logarithmic scale of the chart, if desired. The accuracy of chart plotting and reading, in the case of one-cycle paper ten inches high (such as Keuffel and Esser No. 358–50) is within one part in about 1000. Each point has obviated a division calculation on computing machine or slide rule, with its concomitant tabulation of figures.

The scatter diagram of points on the paper strip shows the distribution of January ratios, arranged in order of magnitude, in their correct geometric proportion. This visual device takes the place of the multiple frequency table, whose positional accuracy is comparable to that of letters in the pigeon-holes of a hotel clerk's letter-box. The linear diagram also brings into relief the peculiarities of the seasonal movement. If the points (which may be numbered chronologically) show a drift along the paper strip, progressive seasonality is indicated. The degree of concentration of points measures the regularity of seasonal movement, and hence the reliability of the seasonal index. Different months may be compared by superimposing the strips.

MEASUREMENT OF AVERAGE SEASONAL VARIATION

First Position *Second Position*

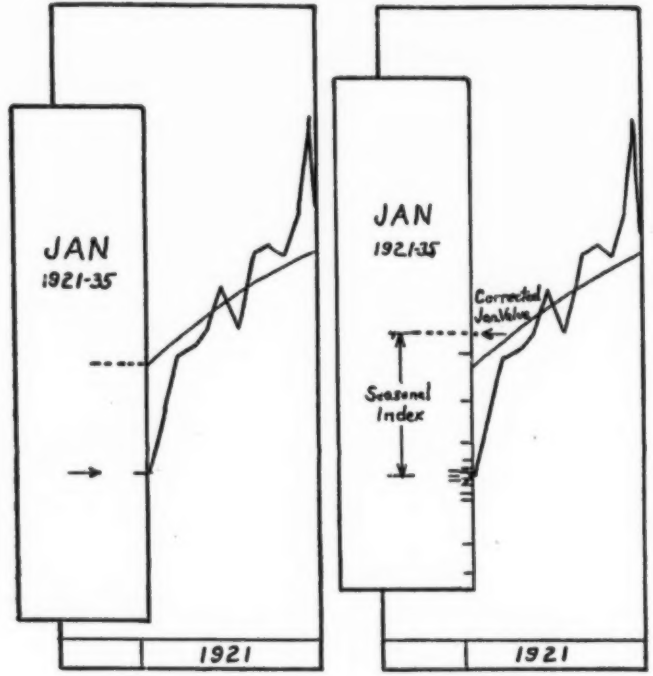


FIGURE 1 FIGURE 2

PROGRESSIVE SEASONAL MEASUREMENT

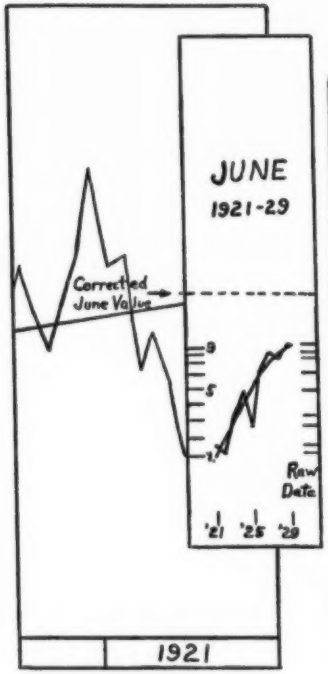


FIGURE 3

TREND-SEASONAL ELIMINATION

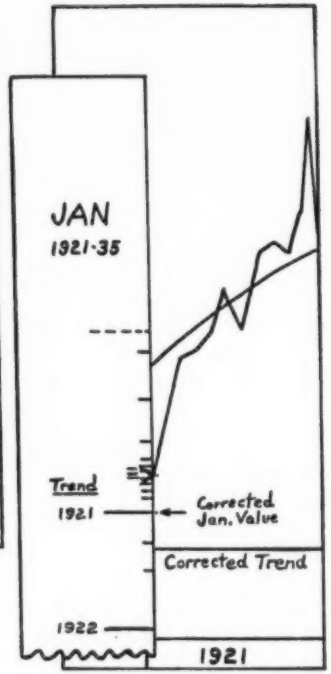


FIGURE 4

Seasonal characteristics may be brought into still clearer relief by plotting a month's successive values chronologically on a strip, as shown in Figure 3. This device is particularly useful for longer periods, and for detecting and measuring progressive seasonal movement. In this case the strip itself should be a piece of ratio paper, with the years (1921–29) marked across the bottom. A month's successive positions are then marked both on the edge of the strip and on its graph, at the same level. The resulting ratio chart serves the same purpose as arithmetic chart used for each month in other methods, but is drawn directly from the original graph without the use of separate charts or figures.

(4) The values marked on the edge of the strip are averaged by inspection. The geometric mean of the central group of items is used, since this type of average is generally more satisfactory for a relatively small number of items than either the median or the mean alone.[7] Extreme items may be discarded at once by inspection. The eye can then proceed from the median to the mean of 3 or 4 central points, thence to the mean of the whole central cluster. The mean is marked on the strip with a caret, as shown in Figure 2, preferably with colored pencil. This brief operation has obviated all the tabulation and computation necessary in deriving the modified arithmetic or geometric mean by numerical methods.

The geometric linear mean of the central cluster, when selected by a skilled observer, is believed to be more reliable than a typical figure chosen from the arithmetic means of successively increasing numbers of middle items, arranged in a numerical table,[8] because: (a) The items which constitute the central cluster may be better identified from the ladder graph than from the table, particularly if the erratic items are skewed. (b) The geometric mean is theoretically superior to the arithmetic mean in ratio analysis. On the other hand, the visual selection of the geometric mean involves a subjective error which calculation of the arithmetic mean avoids.

The distance between the caret and the dotted origin represents the preliminary index of seasonal variation for January, since the use of a line of central tendency as a base eliminated trend (plus a large part of the cyclical element in the case of the trend-cycle curve), and the averaging of January ratios eliminated most of the cyclical and random residuals remaining. The numerical value of the index may be read, if desired, by placing the strip on the vertical scale of the chart. The interquartile range may also be noted, as a measure of deviation.

The preliminary seasonal indexes will yield a seasonally adjusted

[7] Mills, F. C. *Statistical Methods* (New York, 1924), p. 327.
[8] Cf. Kuznets, Simon, *ibid.*

curve whose relative shape is correct but whose average level is slightly too high or too low. The level may be restored, if desired, by adjusting the twelve indexes to average 100 per cent. This can be done graphically on a blank sheet of paper crossed with a horizontal line. The origin of the January slip is placed on this line, and the January index marked off vertically. The February index is laid off vertically from the latter point, and so on until the cumulative level of the December index is determined. The distance between this mark and the horizontal line is then divided by twelve, either visually (by bisecting twice and trisecting), or with a ruler. The resulting segment is applied to the caret on each strip and the corrected index marked in a different color. The preliminary indexes may also be adjusted mathematically by multiplying the numerical value of each by the quotient of 1200 over the sum of the twelve indexes, and plotting the results on the strips.

Progressive seasonal variation is best measured by drawing a free-hand trend curve through the plotted graph on the strip, and transferring each year's trend value horizontally to the left-hand edge of the strip, as shown in Figure 3. If a graph is not used, the points on the right-hand edge of the strip may be resolved visually into a three-point moving median or mean in the center of the strip, and then smoothed by inspection, with the first and last points added, on the left-hand edge. In either case, the distances between the final points and the dotted origin represent the progressive indexes of seasonal variation for June, subject to optional adjustment so that each year's indexes will average 100 per cent. The seasonally corrected values are then plotted as described under (5) below, except that the No. 1 index must be used for the first year (June 1921 in Figure 3), the second index for the second year, and so on.

The distribution of points for any month may be irregular, showing two or more separate clusters. If this irregularity is known to be due to variable seasonal causes, such as the changing number of working days per month, and not to random factors, the months in each group may be corrected by the mean value of that cluster alone. In this way a correction for irregular seasonal variation is obtained. In case the seasonal character of a series changes abruptly, the curve must be broken at the transition point into segments for separate correction, as in other methods.

(5) The paper strip is finally placed again vertically on the chart, this time with the caret on the first January point. The corrected January position is then marked on the chart opposite the dotted line of the strip. These steps are shown in Figure 2. The effect of this shift is the same as that of dividing the January datum by its seasonal index, and plotting the result. The seasonally adjusted curve may be moved away

from the original curve on the chart, for the sake of clearness, by shifting the dotted line on each paper strip a constant distance up or down before plotting the corrected monthly figures.

The seasonal movement of other months is measured and corrected in the same way on separate edges of the same or other paper strips. The revised curve is then drawn through the resulting points on the chart. This curve retains the trend, cyclical and random elements of the original series, eliminating only seasonal fluctuations.

If traces of seasonal variation still persist, the scatter diagrams of the months in question should be scrutinized to determine whether the line of central tendency and the averages were properly chosen, or whether a progressive correction, multiple average or break-up of the series into segments would improve results. The adjusted series may be retraced on a calendar chart, with each year plotted above the next year, in order to reveal more clearly any trace of seasonal residuals.

A graphic application of the link-relative method may be preferred if seasonal relatives are believed to be more stable when based on the preceding month rather than on a given month's "normal" value.[9] This method eliminates the use of a line of central tendency and achieves a partial cyclical correction by means of chain relatives. However, the calculation of these secondary relatives and their correction for trend makes this process more laborious than the other.

The method of eliminating trend and seasonal elements simultaneously is illustrated in Figure 4. The procedure is the same as that already described, with the addition of a single adjustment for the trend factor. A horizontal line of the chart is chosen as a "normal" about which to plot the adjusted series. The paper strip is placed with its dotted origin on the line of central tendency (Figure 1), and the first January position marked on the strip as before. In case a trend line is used, the strip is not moved while the position of the "normal" line is also marked with a long dash (preferably out of the range of January items), and the year (1921) noted alongside. If a trend-cycle curve is used in plotting the monthly relatives, however, a trend line

[9] The link-relative method may be performed graphically as follows: the ratio of each February to the preceding January is measured by setting the paper strip vertically with the central dotted line on the January item, and marking the February position on the strip in pencil. This is done for all the February-January ratios, and the geometric mean of the central cluster is selected as in the other method. The chain relatives are determined on a blank sheet of paper crossed with a horizontal line. Placing the initial January on this line, the January-February mean distance is marked off vertically, and the February point marked. The February-March distance is measured vertically from the latter mark, and so on for 13 months until the second January is located. To correct for trend, the distance between the second January and the base line is divided into 12 equal parts by inspection. The February point is then shifted toward the base line by one of these twelfths, March by two-twelfths, and so on, until the second January is brought to the same level as the first. A horizontal line is next drawn by inspection through the geometric mean of the twelve adjusted points in order to make the average seasonal index equal to 100 per cent. The distances between the adjusted points and this line are finally applied to the plotted data, as in Figure 2, to effect the seasonal correction.

must be added to the chart and the dotted origin of the strip shifted to this line before the location of the "normal" line is marked. The use of a trend-cycle curve throughout would reduce the adjusted series to its random elements and residual errors alone.

The strip is then moved along the original line of central tendency and marked with the other January values and corresponding trend positions. The geometric mean of the central group of January points (not the trend positions) is selected and indicated by a caret, as before. Then the strip is placed with its caret on the first January item as in Figures 2 and 4. The new value for this month, however, is not marked next to the dotted line of the strip (since this would eliminate only seasonal variation), but next to the adjusted trend position for that year, as shown in Figure 4. The caret is then moved to the January of the second year, the second trend position marked on the chart, and so on. The other months are treated similarly, and a curve drawn through the new series of points. This curve should fluctuate about the selected horizontal line without trend or seasonal bias. The distance between the dotted center and a trend mark on a strip represents the trend ordinate for the month in question, just as the spread between the dotted center and the caret denotes its seasonal index. Hence, the distance between the caret and a trend mark of the strip represents the combined factor of trend and seasonality, and a corresponding shift of the original datum effects this compound correction. The cyclical-random elements of the curve have thus been isolated in virtually a single operation without recourse to computation or tabulation of figures.

To recapitulate, the foregoing method of measuring seasonal variation offers three advantages. The most important is that of labor saving The use of computing machines, tables or figures, as well as subsidiary charts or diagrams, is eliminated. Calculation is reduced to its simplest elements. Each month's value is marked by a positional dash, the dashes are averaged visually, and the resulting seasonal index applied to the data directly on the chart. Trend may be eliminated in the same operation with little expenditure of time. Where clerical help is available, the statistician needs only to draw the line of central tendency (or supervise its computation) and to select the mean of the central cluster on each monthly strip, while an unskilled assistant does the rest.

The second advantage of this method is its accuracy, which is roughly equivalent to that of the analogous numerical methods. The average error of plotting or reading on one-cycle ratio paper is about 0.1 per cent, whereas seasonal measurement is rarely reliable within 1 per cent. The geometric mean of the central group of items, visually

selected, is believed to be a reliable type of average. The use of a trend-cycle curve involves a personal error, but reduces cyclical aberration, and draws the monthly relatives closer together, thus reducing the probable error of their mean. The theoretical advantages of averaging ratios to normal values in seasonal measurement are well known,[10] and hence need not be considered here.

The accuracy and computing time of several seasonal methods have been compared by the Statistical Department of the Detroit Edison Company[11] and by Mr. E. Z. Palmer,[12] using a synthetic series with known seasonality. Results are shown below, with the writer's "graphic" method (using a free-hand trend-cycle curve) added in the last row.

Method	Mean deviation from true seasonal, per cent	Mean deviation of monthly arrays, per cent	Computing and checking time, minutes
1. Monthly means	2.0	18.4	60
2. Interpolation	1.7	18.4	110
3. Link-relative	2.0	7.3	160
4. Ratio-to-trend-cycle			
4a. 12 months moving average	1.3	6.2	285
4b. With free-hand correction	0.8	4.9	495
4c. *Graphic*	0.8	4.5	40

This test, while inconclusive, suggests that the free-hand ratio-to-trend-cycle methods are the most accurate, both in the average error of their seasonal indexes (column 1) and in the reliability of the indexes as derived from the monthly arrays (column 2). The graphic method retains the accuracy of its numerical counterpart (4b), but decimates its computing time (column 3).

The third advantage is that of flexibility. Central tendency may be measured by a trend or trend-cycle curve, annual or cyclical averages, a horizontal line, or by chain relatives, whichever is most appropriate. When the values of a given month are marked on a paper strip, the resulting scatter will reveal any peculiarities of seasonal movement—whether progressive, abruptly shifting, irregular, or otherwise distinctive. The appropriate method of correction may then be chosen and carried on from that point, without starting anew. In the final step, seasonality may be eliminated either with or without trend from the series. The graphic medium affords a continual visual check on successive operations, promptly revealing errors in measurement or judgment, and allowing necessary variations of technique. Semi-annual, quarterly and weekly data may be treated in the same way as monthly material.

[10] Mills, F. C., *op. cit.* pp. 323, 324, 328; Hall, L. W., *ibid.*

[11] "A Mathematical Theory of Seasonal Indices," *Annals of Mathematical Statistics*, Vol. I (1930), pp. 57–72.

[12] "Error and Unreliability in Seasonals," *Annals of Mathematical Statistics*, Vol. I (1930), pp. 345–351. See especially pp. 348–350.

THE CONSTRUCTION OF TWO HEIGHT CHARTS

By May Ayres Burgess
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This is a description of the construction of a pair of Height Charts for American boys and girls which show the distribution of heights at each age and the height curves along which children tend to grow. Hundreds of height studies have been published and many of them have been made under careful scientific guidance. Yet when the parent or teacher or physician wishes to know whether an individual child is shorter or taller than would reasonably be expected, and whether his rate of growth is normal or abnormal, he finds the question difficult to answer. The same child may be regarded as far below average in the light of one study and far above average in the light of another. Whether he ought or ought not to be about where he is is largely determined by the individual opinion of the examiner. What appears to be needed most is not another field study of stature but a merging of the results of many studies to produce a practical device for recording the growth records of children and making judgments concerning their significance.

UTILIZING EXISTING STUDIES

As finally constructed, each of the two new Height Charts, one of which is shown in Diagram 3, consists of a central or 50 per cent line, showing the height of the average American child at each age from 1 to 21 years. Above and below this central line, not quite parallelling it, are other lines for 99 per cent, 90, 80, 70, etc., showing the heights of those children who are so tall that 99, or 90, or 80, or 70 per cent, etc., of all American children of their age are shorter than they. When an individual child's record is plotted on the chart it is therefore possible to note not only whether he is taller or shorter than the average, but what height level he is on as compared with the typical level for his social-economic group, what percentile path he is most closely following, and whether the amount of growth he makes over a given period is the same as, or more or less than, the amount of growth usually made by other children at his level.

The first step in constructing these charts was to determine the values of the central or 50 per cent lines. Some 60 different sets of averages[1] were used in making the study, but not one study reported reliable measurements for every age from 1 through 21 years, and no one of

[1] See the list, p. 307.

the sets agreed throughout its length with any of the others. Diagram 1 illustrates the nature of the problem. This diagram shows the "average" heights for American boys of different ages as shown by 18 of the studies.[2] Which is the most reliable average for the typical American boy of, say, 10 years? How much does the typical boy grow between the ages of 13 and 14? How tall is he at 21? No one of the available studies could be taken as the sole guide in answering such questions as these.

The simple device of combining the results of all the studies by a process of weighted averages could not be used. There were several reasons. The first and rather surprising one was that many otherwise excellent studies fail to state the numbers of cases included in different calculations, or to give any measures for dispersion. Strikingly little information is given as to the social-economic levels of the groups being studied. Moreover, several of the larger and more helpful studies showed evidence of bias in the selection of certain age groups which could not be corrected by any ordinary weighting process.

A new nationwide study of sufficient scope would not only have been expensive and time consuming, but—which was more serious—even a very large and careful study would probably have suffered from many of the weaknesses of its predecessors. To make a thoroughly reliable height study is not easy. Heights must be taken accurately; in most school records they are very inaccurate. Ages must be verified, especially when they are being classified to the nearest month. Large numbers of children must be measured at each age, because so little is known as to what determines variations in growth that it is as yet practically impossible even with elaborate precautions to select a small group of children every one of whom presents a completely normal growth picture. Children who seem alike at one age may a few years later present startling differences, and if the group is small a few such cases may distort the resulting figures. The selection of children must be intelligently inclusive, for until more is known about what constitutes normal growth the statistician should regard critically those studies which say, in effect, "Children so tall or so short as to be obviously abnormal have been omitted from this study."

Fully as important and much more difficult to guard against are the variations from age to age in the social-economic level, which many careful pieces of research have shown to be positively correlated with height.[3] Studies in public school systems, made many years ago, often

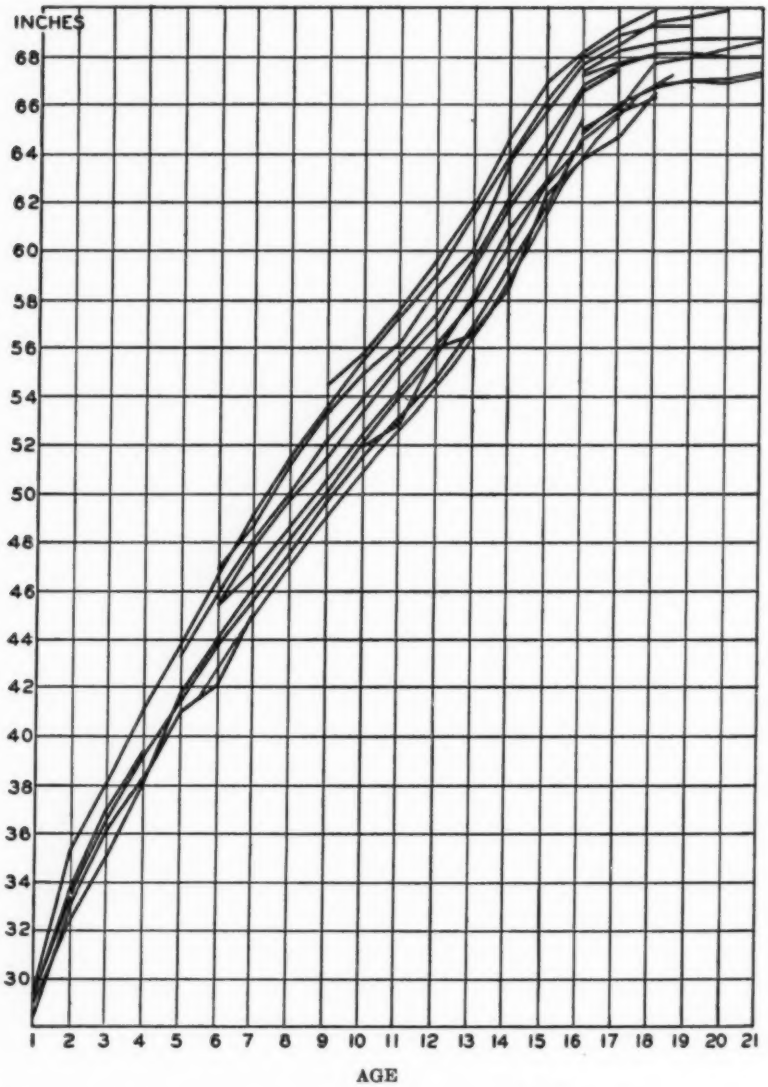
[2] In Diagrams 1 and 2, because of the great amount of overlapping, only studies fairly far apart are shown, and no attempt is made to label the different ones.

[3] For an exceptionally complete digest of these findings for children in different countries, together with full bibliography, the reader is referred to Barkev S. Sanders, *Environment and Growth* (Baltimore: Warwick and York, Inc., 1934).

showed children in the upper grammar grades taller than the records from the lower grades would have seemed to predict. The reason prob-

DIAGRAM 1

AVERAGE HEIGHTS OF BOYS REPORTED BY 18 DIFFERENT STUDIES



ably was that as they grew older the poor children dropped out of school to go to work. In general poor children are shorter than those

whose parents have more money, so that by leaving school they raised the average height for those who remained. Similarly it seems probable that some of the recent figures for heights of private school children have been raised or lowered at different ages by shifts in the average economic level of the pupils. On the higher economic levels the average for five year old school children, and for 16 year old college students is often greater than heights at other ages for the same schools would indicate, probably because the parents tend to hold back short children and push tall children ahead. On the other hand, in thickly populated districts the average heights of five year olds may be low because poor parents hurry their children into school to keep them off the streets.

The difficulty of making any new height study which would avoid all these errors is obvious. It seemed probable that quite accurate results could be secured, not by trying to measure several hundred thousand more children, but by analyzing and combining the best of the already existing studies in such a way that their non-typical figures would be identified and omitted and their typical ones utilized. Some of the 60 studies used were of pre-school children, others of pupils in the grades, others of high school boys and girls, and still others of college students. Measurements were for children of different social and economic levels, for different racial groups, and different geographic locations. Some were for very large numbers of cases and some for very few. Some were for one sex only and some for both. Certain studies were made recently, while much of the most valuable material was gathered more than 40 years ago. There were many evidences of selective bias. Yet in spite of such differences, and in spite of the fact that no two sets of average heights per age were the same, all of these studies showed certain striking characteristics in common. The new charts were constructed by identifying, segregating, and combining those universal attributes.

THE METHOD OF DIFFERENCES

When the averages for the many studies were plotted together on one sheet (as in Diagram 1), although some were high on the scale and others low they all followed essentially the same pattern. Average heights for one year old boys varied, but all of them were less than 32 inches. Average heights for 21 year old boys also varied, but all of them were over 65 inches. Throughout their course, from one to 21 years, the different studies stayed rather closely together; because essentially they were all measuring slightly different manifestations of the same thing, which was growth in human stature. They bore the

unmistakable appearance of curves changing according to the dictates of a controlling law.

Height curves may be thought of as cumulative lines in which each year's growth is added to the total reached the year before. The pattern which growth is following—whether it is accelerating or diminishing, and how rapidly—may be seen by breaking down each cumulative line into its separate annual increments. If we know that in one famous study the heights of boys from one to five years averaged in inches: 29.4, 33.6, 36.7, 39.2, and 41.6, we are apt to think only of the rapid growth shown by little children. If, however, we break those figures down to show how much growth occurred each year, and find annual increases of 4.2, 3.1, 2.5, and 2.4 inches, what impresses us is the rapidity with which the initial rate of growth decreases. When corresponding figures from other studies are found to be closely similar, we then have a basis for estimating just about how much growth may be expected in the average child every year. Essentially, this was the process followed in building the central tendencies of the new Height Charts.

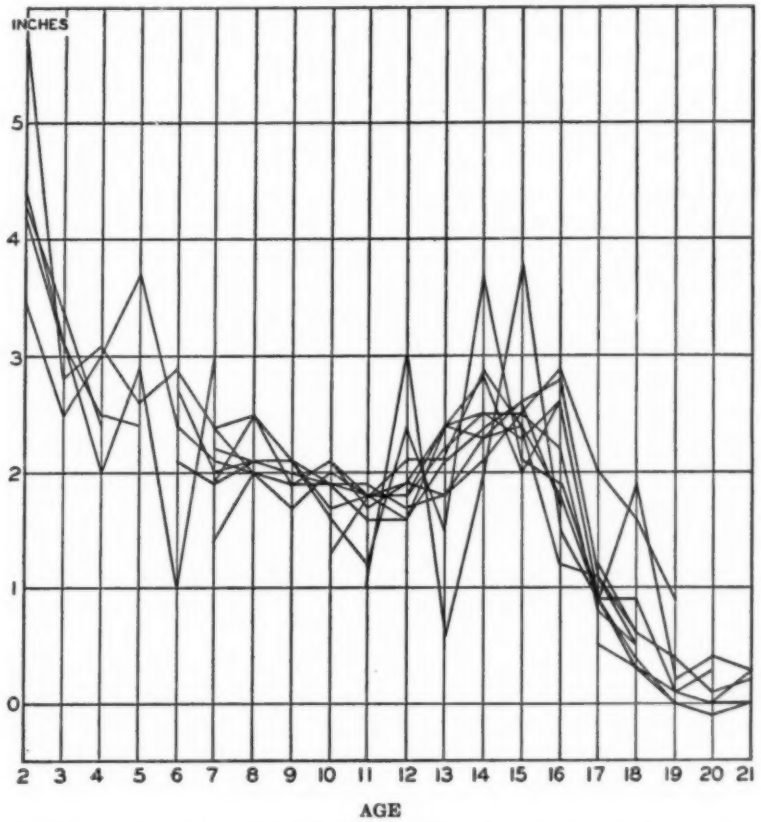
For each sex the first, second, and third differences (annual increments, differences of increments, and differences of these differences) of the height averages in each of the 60 studies were computed. It might have been possible by some process of weighting to combine these 60 lines directly into one master line. As has already been pointed out, however, so many of the studies failed to give full information concerning the methods by which the data were gathered that proper weighting seemed out of the question. Moreover, there were certain important accidents in selection which would not have been caught by the smoothing process. Each of the three set of differences was plotted in a master diagram. Most of the differences, being approximately true ones, were so nearly identical that they clustered closely together in the diagram, often within an area representing only half an inch of growth, but differences which had been derived from non-representative measurements, either for a single year or for a long series of years, stood strikingly apart from the others. The points representing the great bulk of the studies fell into a narrowwinding stream or track which could be followed rather clearly from year to year. The data from the great majority of height studies fell within its narrow boundaries and defined its course. Evidences of selective bias in the studies were made conspicuous by the way in which data derived from them departed from the common path. This is illustrated by Diagram 2 showing yearly increments, or first differences, of the average statures of boys. For clearness, only 18 of the 60 studies in the

master diagram are shown. The distinctive pattern can be clearly seen. In this way it was possible, by disregarding the few abnormal differences, to locate for each diagram a trend line representing the central tendency of what the differences would have been had all the studies been free from selective error.

DIAGRAM 2

AVERAGE ANNUAL INCREMENT IN HEIGHTS OF BOYS IN 18 DIFFERENT STUDIES

Increase from average height of preceding year



The first, second, and third differences of average heights for boys and girls yielded six master diagrams. In addition there were two other master diagrams which were of major importance because they checked and controlled the other six. They were the diagrams showing the differences between the averages for boys and the averages for girls at each age and the differences of these sex differences. While boys and girls show typical patterns of growth, their patterns are not the same

yet in the comparison, certain accidents of measurement which might not have been detected when the sexes were treated separately were brought strikingly to light and the streams or paths of differences which characterized the first six master diagrams were subjected to an additional check and verification. Space does not permit reproduction even in abbreviated form, of all eight master diagrams in this article.

The plan for constructing two theoretical lines of average heights, one for boys and one for girls, was to find the central trends of the 60 studies for each of the eight sets of differences, and then derive from these trends the two lines of average stature. Since all eight had been drawn from a common source, it followed that they all interlocked, so that the change of even one average in one of the basic studies involved corresponding changes in at least five of the diagrams and a change for both sexes meant revisions in every one of the eight. Since this was true for the individual studies, it followed that the true central trend lines for the differences of the eight master diagrams must not only lie within their respective channels and conform to the controlling direction of those channels, but all eight must also show the same interlocking.

To determine the true trend lines called for much careful experimenting. The procedure followed, starting with the third differences and working backward, was to find the marginal limits of the trend at each year in each of the eight master diagrams; locate the mid point value; and then, by a series of approximations, shift the location of each one of these mid points slightly up or down within the limits of its stream until the value of each interlocked with the corresponding values of the other seven.

In so long a series of adjustments, the laboring statistician is comforted by the words of Galton, in his presidential address of 1885 to the Anthropological Institute, where he tells of counting his pedigreed flower seeds from which he discovered the law of regression. He says: "the data ran somewhat roughly and I had to smooth them with tender caution." In the work on the Height Charts also, smoothing with tender caution had at this point to be resorted to.

When the interlocking trend lines for the eight diagrams had at last been identified, two lines were constructed from them, one for the average heights of boys and one for the average heights of girls, at each age from 1 to 21 years. These became the 50 per cent lines in the Height Charts. The figures finally adopted as the trends of first differences, or annual height increments, and for boy heights minus girl

heights are shown in the first three columns of Table I. The two columns at the extreme right show the average heights for boys and for girls which form the central tendencies for the Height Charts and which were constructed from these figures.

TABLE I

ANNUAL INCREMENTS AND SEX DIFFERENCES IN HEIGHT AS DERIVED FROM SIXTY STUDIES, AND RESULTING AVERAGE HEIGHTS FOR BOYS AND FOR GIRLS*

Inches

Exact age in years	Annual increments		Difference between sexes	Average heights	
	Boys	Girls		Boys	Girls
1	4.22	4.22	.35	30.25	29.90
2	3.20	3.20	.35	34.47	34.12
3	2.70	2.70	.35	37.67	37.32
4	2.42	2.42	.35	40.37	40.02
5	2.24	2.24	.35	42.79	42.44
6	2.10	2.10	.35	45.03	44.68
7	2.00	2.00	.35	47.13	46.78
8	1.92	1.92	.35	49.13	48.78
9	1.86	1.94	.35	51.05	50.70
10	1.80	2.12	.27	52.91	52.64
11	1.74	2.35	−.05	54.71	54.76
12	2.16	2.34	−.66	56.45	57.11
13	2.44	1.66	−.84	58.61	59.45
14	2.47	1.00	−.06	61.05	61.11
15	2.00	.49	1.41	63.52	62.11
16	1.19	.16	2.92	65.52	62.60
17	.48	.01	3.95	66.71	62.76
18	.19	.01	4.42	67.19	62.77
19	.07	.01	4.60	67.38	62.78
20	.05	.01	4.66	67.45	62.79
21			4.70	67.50	62.80

* The average height for American boys at 21 years is taken as 67.5 inches. See discussion below.

An additional step was necessary before the averages could be computed. It was to find a starting point. This had to be an arbitrary decision, for at no age is there a completely reliable height average. The figure finally taken, because there was better evidence for it than for any other, was for the height of the average American man on his 21st birthday. With that as a finishing point, the values for the last two columns in the table could readily be determined. No one knows exactly how tall the average American man is. There are few studies for that age, and those that are available do not agree. Were

the influence of immigration removed, there is evidence to indicate that the average height of our men would show slight but steady increases from year to year; but these increases are in such large measure offset by the shorter stature of incoming foreigners that the mean stature of the first million draft recruits in the U. S. Army in 1917–18 was almost exactly the same as the mean stature of recruits during the Civil War more than 50 years earlier.[4] This figure, which was 67.5 inches, was therefore taken as proably the safest estimate for the average American man when he reaches voting age today. It may be slightly too low. It is almost certainly not too high. The two sets of height figures were built down from that finishing point.

THE SURFACE OF DISTRIBUTION

Height Charts, to be useful in studying individual growth records for children of different social-economic-geographic levels, must show not only heights at each age for average American boys and girls, but also corresponding figures for the growth curves of children at different levels in the general distribution below and above the average. This means that the forms of the distributions at different ages must be determined. For homogeneous groups of adults the height distribution takes approximately the form of the "normal" or Gaussian curve, but it has been stated by some investigators that for growing children the distributions are not normal but skewed.

Perhaps it is true that at certain ages, especially those of adolescence, the distributions of children's heights are characteristically skewed, but the available evidence is not convincing. When one tries to state for any given year whether the skewness is large or small, positive or negative, the comparison of data from different studies does not give much help in arriving at a decision. Unfortunately most height studies do not publish the facts necessary for determining the shape of the distribution curves; but some idea of the differences in results where the data are available may be gained from the six sets of findings in Table II.

By the familiar formula, "Skewness equals three times the Mean minus the Median, divided by the Standard Deviation," perfect symmetry would have a coefficient of zero and moderate skewness a coefficient of about $\pm .25$. When this formula is applied to the data for heights of adult males born in the British Isles (Yule, C. U., *Introduction to the Theory of Statistics*, p. 88 et seq.), we find that skewness

[4] For discussion of the World War and Civil War figures, see Davenport, C. B. and Love, A. G., *Army Anthropology* (Washington, D. C.: 1921), p. 67 et seq.

equals .01. As will be seen by inspection of Table II, most of the distributions represented there more nearly approach symmetry than they do moderate skewness. Where the coefficient of skewness is high for a given year in one study the coefficient immediately above or below it,

TABLE II

COEFFICIENTS OF SKEWNESS FOR AVERAGE HEIGHTS OF BOYS

Age	Woodbury		Boas	Clark, Sydenstricker, Collins	Burgess	Diehl
	1 month span	12 month span				
1	.08	.11				
2	.06	.04				
3	.05	.05				
4	−.03	−.01				
5	.02*	−.02	.06			
6		−.14	.09	.21*		
7			.05	−.23*		
8			.05	0*		
9			.03	0*	−.22*	
10			.03	0*	.07*	
11			.03	.11*	.02*	
12			.13	.20*	−.07*	
13			.12	.10*	.25*	
14			.14	.08*	.16*	
15			−.05	−.08*	−.04*	
16			−.24*	−.30*	.08*	−.21*
17			−.04*		−.31*	−.02
18			−.13*		−.23*	−.07
19						0
20						0
21						−.02

Sources; Woodbury, R. M., *Statures and Weights of Children Under Six Years of Age* (U. S. Dept. of Labor, Children's Bureau, 1921). Boas, F., *The Growth of Toronto Children* (U. S. Bureau of Education, 1896, 7. 1898). Burgess, M. A., Unpublished study of the heights of 600 boys in the Riverdale Country School, New York City. Diehl, H., "College men," *Human Biology*, Vol. 5 (Sept., 1933).

* The number of children measured was less than 1,000.

or for the identical year in some other study, may be low. The greatest apparent skewness usually appears in studies where the numbers of children measured are small.

It would be helpful if distribution studies could be made with special emphasis upon securing large numbers of children in homogeneous age groups. If, especially during adolescence when growth is rapid, children could be measured on their birthdays, instead of to the nearest birthday (which may be six months away), or to the past birthday (which

may be nearly 12 months away), and if large numbers could be measured at each age, it might be that the skewness shown in some of the studies would largely disappear. Or, if the skewness is real, such a study might show at what ages it occurs and how great it is at each age.

After reviewing the evidence now available, it was decided that for practical measuring purposes the most reasonable assumption is that for either sex at any exact age the heights of children are distributed in something very nearly approaching the normal distribution. A chart based on that assumption may be slightly misleading in its extreme outer ranges, when the measures of dwarfs and giants are being considered, but, in the light of present information, it will probably be less misleading than if skewed distributions for the adolescent period were arbitrarily adopted. The charts were therefore constructed on this basis.

For the growth percentile lines above and below the average it was next necessary to determine the standard deviations at different ages. Unfortunately, many height studies fail to include in their published reports either the frequency distributions for different ages or computed measures of variability. Such data as are available, however, indicate that where the number of cases at each age is sufficiently large and the selection consistently representative the standard deviations of height distributions follow growth patterns much as do the figures for averages. With some modifications made necessary by the relatively small number of studies available, the technique already described for deriving a master series of averages by analyzing the fundamental difference trends of existing studies was also followed in determining the master series of standard deviations.

Until the age of 7½ years, the standard deviations for boys and girls are practically the same. Their yearly increments, like those for averages, are high during the first year and gradually decrease. The downward trend of yearly increments reaches its low at 6½ years, and then starts rather slowly upward for both sexes. The sharp upward adolescent spurt in the standard deviations begins at about 9½ years for girls and at about 10½ years for boys. The high point for girls is reached shortly before the 13th birthday, and the descent from that point is very rapid, so that from the age of 17 the standard deviations of the height distributions for girls have practically reached their final adult level. From 13½ on, the heights of boys are much more variable than those for girls. The top of the boys' adolescent peak does not come until just after the 15th birthday; and the final adult level is just being approached at the age of 21. The standard deviation for the first million

American draft recruits in the World War was 2.71 inches. In making the Height Charts this figure was raised to allow for the extra variation which would have occurred had the Army recruits included men under 59 inches or over 79. It is possible that this figure should be even a little higher; but it should probably not be any lower.

TESTING THE CHARTS AGAINST THE 60 STUDIES

After the lines for average heights and for standard deviations had been constructed they were tested for accuracy in terms of the 60 studies from which they had been drawn. The averages of all the studies available for a given year were translated so that each became a percentile point in a normal distribution determined by the average and standard deviation for that year. At age 10, for example, with the theoretical average for boys at 52.91 inches and the theoretical standard deviation at 2.27 inches, the entries for five of the studies were translated into percentile points as follows:

Study	*Average height*	*Percentile point on Height Chart*
Boas	51.0	20
Holt	52.2	38
Clark, Sydenstricker, Collins	52.6	45
Baldwin Score Card	53.5	60
Gray Ayres	55.6	88
Height Chart, Boys	52.9	50

In theory, if the Charts were properly constructed, any given study should maintain approximately its same percentile position for every year on the Height Chart. If, in the distribution for 10 year old boys the Boas average was at the 20 per cent level and the Gray, Ayres average at the 88 per cent level, we should expect the Boas and Gray, Ayres averages to maintain their positions near 20 per cent and 88 per cent at 5 years, 8, 12, and 15 years. Their percentile positions would change from year to year only (a) if the samplings were so small or so biased as to produce fluctuations, or (b) if the social-economic level of the group being studied shifted—which apparently happens rather frequently, or (c) if the Height Chart itself, in terms of which the percentiles were found, needed adjustment.

Where fluctuations in the percentage levels were due to weaknesses in the studies themselves, such fluctuations would be inconsistent with each other, and would occur at different years and in different directions. But if, for example, one of the averages of the Height Chart were too high at one year, most of the percentages for the different studies

would show a drop at that particular year, and would therefore point unmistakably to the error in the average shown on the Chart. By lowering the average, perhaps even so little as one tenth of an inch, the corresponding percentages might be raised and their fluctuations ironed out.

The tables as drawn up covered the averages of all the studies at all the ages, translated in terms of percentile points on the new charts. To test the validity of the theoretical charts, these percentiles were then recomputed to see what they would be at each year if the Height Chart average were raised or lowered. The percentiles shown for the five studies just cited, for example, where the Height Chart average for 10 years was 52.9 inches, were recomputed for possible averages of 52.6, 52.7, 52.8, 53.0, 53.1, and 53.2. Similar tests were made for all the studies at all ages for both sexes.

As a matter of fact, this testing of the theoretical averages against the averages of the 60 studies proved hardly necessary. Surprisingly few adjustments had to be made; but the process did contribute to the writer's confidence in the validity of the work. The averages which were finally adopted and which now appear at the even years along the 50 per cent lines of the two Height Charts are those which, while derived from and conforming to the relationship trends determined in the eight master diagrams of differences, also make for the least variation in the percentile levels of the contributing studies.

The standard deviations were tested in a similar manner. If the tentative average had been a little too high, that fact would have been indicated by a general down dip in most of the percentile values for the several studies, both above and below the 50 per cent line. If, however, the average had been correct but the standard deviation too large, the percentile values of studies near the middle of the distribution would have remained fairly steady, while those near the upper limits would have tended to drop and those near the lower limits to rise at the age in question. The standard deviations finally adopted were those which most nearly controlled such fluctuations in the very high and very low percentile levels, while still conforming to the requirements for the trends of differences.

When the averages and standard deviations had been determined for even years the monthly figures were interpolated. Care was taken to see that the monthly increments, and the differences between those increments, increased and decreased in harmony with the direction in which the yearly increments were moving. Finally, the percentile points in each month's distributions were determined, from one year to 21

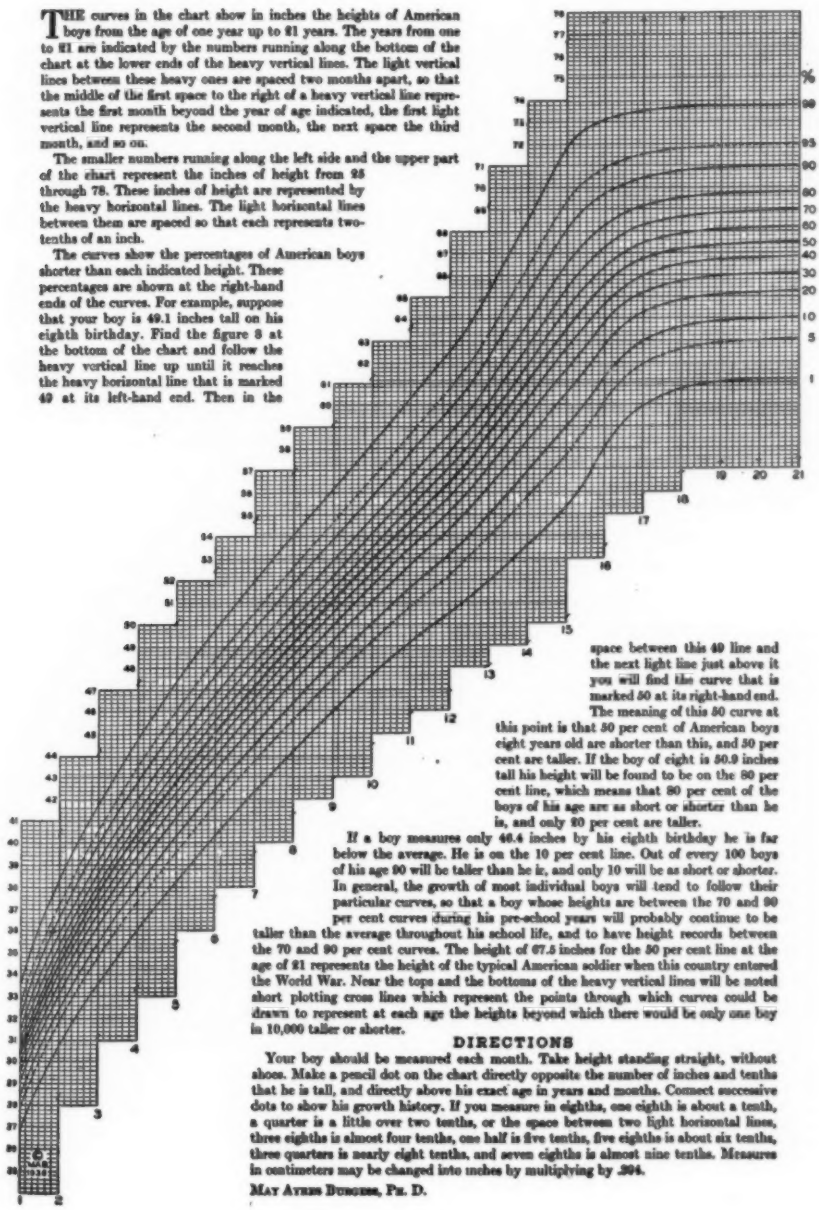
DIAGRAM 3

THE HEIGHT CHART FOR BOYS

Slightly less than one half scale

HEIGHT CHART—BOYS

NAME_____ DATE OF BIRTH_____ ADDRESS_____



THE curves in the chart show in inches the heights of American boys from the age of one year up to 21 years. The years from one to 21 are indicated by the numbers running along the bottom of the chart at the lower ends of the heavy vertical lines. The light vertical lines between these heavy ones are spaced two months apart, so that the middle of the first space to the right of a heavy vertical line represents the first month beyond the year of age indicated, the first light vertical line represents the second month, the next space the third month, and so on.

The smaller numbers running along the left side and the upper part of the chart represent the inches of height from 28 through 78. These inches of height are represented by the heavy horizontal lines. The light horizontal lines between them are spaced so that each represents two-tenths of an inch.

The curves show the percentages of American boys shorter than each indicated height. These percentages are shown at the right-hand ends of the curves. For example, suppose that your boy is 49.1 inches tall on his eighth birthday. Find the figure 8 at the bottom of the chart and follow the heavy vertical line up until it reaches the heavy horizontal line that is marked 49 at its left-hand end. Then in the space between this 49 line and the next light line just above it you will find the curve that is marked 50 at its right-hand end. The meaning of this 50 curve at this point is that 50 per cent of American boys eight years old are shorter than this, and 50 per cent are taller. If the boy of eight is 50.9 inches tall his height will be found to be on the 80 per cent line, which means that 80 per cent of the boys of his age are as short or shorter than he is, and only 20 per cent are taller.

If a boy measures only 46.4 inches by his eighth birthday he is far below the average. He is on the 10 per cent line. Out of every 100 boys of his age 90 will be taller than he is, and only 10 will be as short or shorter. In general, the growth of most individual boys will tend to follow their particular curves, so that a boy whose heights are between the 70 and 90 per cent curves during his pre-school years will probably continue to be taller than the average throughout his school life, and to have height records between the 70 and 90 per cent curves. The height of 67.5 inches for the 50 per cent line at the age of 21 represents the height of the typical American soldier when this country entered the World War. Near the tops and the bottoms of the heavy vertical lines will be noted short plotting cross lines which represent the points through which curves could be drawn to represent at each age the heights beyond which there would be only one boy in 10,000 taller or shorter.

DIRECTIONS

Your boy should be measured each month. Take height standing straight, without shoes. Make a pencil dot on the chart directly opposite the number of inches and tenths that he is tall, and directly above his exact age in years and months. Connect successive dots to show his growth history. If you measure in eighths, one eighth is about a tenth, a quarter is a little over two tenths, or the space between two light horizontal lines, three eighths is almost four tenths, one half is five tenths, five eighths is about six tenths, three quarters is nearly eight tenths, and seven eighths is almost nine tenths. Measures in centimeters may be changed into inches by multiplying by .394.

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years, for 1, 5, 10, 20, 30, 40, 60, 70, 80, 90, 95, and 99 per cent. From these figures the Height Charts for Boys and for Girls were drafted.

THE HEIGHT CHARTS IN USE

Diagram 3 shows the Height Chart for Boys as it is now being used. Each Chart is printed in green ink, on a sheet of 11×17 inch paper, so that when folded once it can be inserted in a standard manila record folder. Measures are given in inches, not in centimeters, because most people do not think readily in terms of centimeters, and it was desired to make the charts as simple as possible for practical use. While in order to secure smoothness the original computations were made in hundredths of an inch, the instructions suggest that no attempt be made to measure heights closer than to one-tenth of an inch. In fact, for most situations careful measuring to the nearest quarter inch will prove near enough for all practical purposes. It is more important to take measures carefully and frequently than to seek exact scientific accuracy on any one of them.

It should also be stressed that while the 50 per cent lines on the charts probably conform closely to the average heights of American children, and while they are very useful in certain clinical calculations, they emphatically do not represent what is "normal" for all children. Different social economic groups have different normals. A child on the 50 per cent line may be short for his age if he belongs to one group, at normal height if he belongs to another, and tall for his age if he belongs to still a different group. One of the purposes which these charts may serve is better to define for different groups of children what may reasonably be expected in the rate of growth.

Research in which the two charts are used as tools has been under way for only a short time, but the experience so far harmonizes with what is already known about growth. Year by year school height records for 922 school children have been collected and compared with the chart curves. Typically the height of a normal child follows fairly closely along his particular percentile path. He grows by fits and starts, so that his growth line is sometimes below and sometimes above, but the general trend conforms fairly closely to the percentile line. The curves bear out the findings of other investigators who report high positive correlations between adult stature and stature in childhood. Tall children start the adolescent spurt earlier than short children; and in most cases the short boy becomes a short man; the tall boy becomes a tall man.

If a child grew evenly, like clockwork, (which he does not), with no

unusual glandular changes, his height expressed in percentiles would apparently remain about the same throughout his life. If, that is, at the age of one year he is so tall that only 25 out of every 100 children are taller than he and 75 out of every 100 are as short or shorter, he is growing on the 75 percentile line, and theoretically he will continue on that line, so that when he is five years old, or 10, or 14, or 21, it will still be true that out of every 100 children of his sex and age only about 25 will be taller and about 75 will be as short or shorter. What children actually do, as indicated by their school records, is shown in Table III, which contains height reports in terms of percentiles for eight boys selected as typical from large numbers of similar cases.

TABLE III

HEIGHTS ON DIFFERENT BIRTHDAYS IN TERMS OF CHART PERCENTILES FOR EIGHT TYPICAL SCHOOL BOYS

Birthday	1	2	3	4	5	6	7	8
6				75			5	
7				71	55	25	5	
8	97	85		70	54	28	10	
9	97	88		72	45	25	12	5
10	99	90	89	74	41	23	9	3
11	99	90	88	76	46	24	11	3
12	98	93	88	73	40	26	10	4
13	97	92	85	71	45	27	9	4
14	97	96	89	70	50	23	7	3
15		90	90	70	50	20		2
16		89	87		45			1
17			87					
18			86					

There are, of course, many records which do not run as evenly as these. There is a group of children, for example, who travel along a low level year after year, and then suddenly, with the onset of adolescence, shoot rapidly upward, so that they may rise 30 or 40 points in the percentile distributions. Apparently this type of growth is comparatively rare. Most short children do not experience such a spurt, but where it does occur it is so striking that it attracts attention.

Many of the apparent irregularities of growth are really due to carelessness in measurement. The rate at which a child is growing is beginning to be regarded as one of the important indicators of his general physical condition; but as yet there is little in medical literature dealing with the problem. Many school and private physicians who watch weight very carefully are content to measure height "to the nearest inch" often without regard to posture, or to measure with shoes sometimes on and sometimes off so that, according to their records, children apparently shoot up or shrink down in the most startling fashion. In many records, especially for younger children, heights and weights are transposed on the record card and much interpretation is needed to get the height picture approximately accurate.

When a height chart is kept for the individual child, and his height

line entered month by month or term by term, an error in measurement stands out as dramatically as does a wrong thermometer reading on a fever chart. Where measurements are verified but the child suddenly begins to grow at an abnormal rate, either much faster or much more slowly than is usual, the graphic record gives parents, teachers, and physicians prompt warning that he needs to be kept under close observation, and possibly given special medical care. The physician does not, of course, make a diagnosis based on height alone, but a careful growth record is often a valuable diagnostic aid.

A few years ago the writer became interested in the experimental growth studies which are being carried on by Dr. Josephine Hemenway Kenyon at the Endocrine Clinic, of which Dr. Irving H. Pardee is Chief, of the Vanderbilt Clinic in New York City. The idea of constructing these Height Charts grew out of the evident need for such an instrument in measuring the effectiveness of hormone growth stimulation; and the plan was gradually enlarged to trace the growth patterns of other types of children as well. The charts were put into active use over a year ago, and one is now being kept routinely for every growth patient receiving care at the Clinic. These charts have contributed useful evidence on the rate of overgrowth in the early diagnosis of pituitary tumors and recorded graphically the changes in the patient's rate of growth under X-ray treatment. Growth abnormalities have been detected in apparently normal children; and, in the cases of children who because of slow normal growth or dwarfism are receiving growth stimulating therapy, a statistical technique is gradually being worked out for differentiating between the amount of growth which would probably have occurred had the child received no medical care and the amount which may fairly be attributed to the specific medical treatment.

The Height Charts are not yet perfected scientific instruments. Practice in the use of them will undoubtedly suggest needed changes. It is believed, however, that in their present form they are sufficiently accurate so that they will prove useful tools in the hands of parents, teachers, and physicians who wish to watch the progress of children and to identify in the early stages those who present growth problems. For investigators who are concerned with classifying special groups of children according to their characteristic growth patterns, the Charts should be especially useful because of the facility with which heights at different ages can be translated into common terms (as illustrated in Table III) so that deviations from the typical growth patterns can be readily measured. The Height Charts should also be of assistance to

physicians who wish graphic records of changes in height in growth cases under observation and receiving medical treatment.

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METHODS AND PROBLEMS OF SAMPLING PRESENTED BY THE URBAN STUDY OF CONSUMER PURCHASES*

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The purpose of this paper is to present to social scientists the problems of sampling encountered in the Urban Study of Consumer Purchases and to indicate the methods designed to meet these problems. This discussion is concerned only with the Urban Study because the rural areas included in the coordinated studies presented problems of sampling quite different in many respects from those of the cities.

The authors believe that frank discussions of sampling problems are essential to an intelligent interpretation of the data resulting from any study. Furthermore, it is believed that the Consumer Purchases Study provided unusually diversified problems of sampling, so that the experience gained should be not only of interest to the student of Consumption, but also of value to social scientists who make use of sample data.

The experience gained in the field of sampling is considered of technical interest for two reasons: (1) The study included four distinct samples—a random sample, a selected random sample, a stratified sample, and a controlled sample. (2) The study was undertaken on a very large scale in all sections of the country, in thirty-two communities of varying sizes ranging from Wallingford, Connecticut, with a population of approximately 11,000 to New York City.[1]

Four different samples were obtained in the study to secure the desired data on the consumption habits of American families in the

* Revision of a paper presented at the Ninety-eighth Annual Meeting of the American Statistical Association (at a joint session with the American Farm Economic Association), Chicago, December 29, 1936.

[1] For those unfamiliar with the survey it should be pointed out that the plans for the Consumer Purchases Study, which was undertaken as a Federal Works Project, were developed jointly by the Consumption Research Staff of the National Resources Committee, the Cost of Living Division of the United States Bureau of Labor Statistics, and the Economics Division of the United States Bureau of Home Economics, with the cooperation of the Central Statistical Board. The data collected in the survey were obtained by the schedule method through personal interview with the families. The project is administered in urban communities by the Bureau of Labor Statistics and in some small cities, in villages and farm areas by the Bureau of Home Economics. A Steering Committee composed of representatives of the cooperating agencies is guiding and coordinating the project. For a short description of the study, see the articles "Plans for a Study of the Consumption of Goods and Services by American Families" this Journal, Vol. 31 (March, 1936), pp. 135–150, and "Consumer Purchases—Some Results of a National Study," by A. D. H. Kaplan, *Proceedings of the Boston Conference on Distribution*, September 29, 1936.

most effective way possible. Since the collection of these statistics on family expenditures and family living requires great skill and is very time consuming, it was of paramount importance to plan the size and the character of the sample very carefully. The plan devised called for the collection of data on consumer expenditures from a controlled sample, selected according to income, occupation and family type, and in addition, of data from a random sample which would indicate the relative importance of each group included in the controlled sample.

The general plan was to draw a random sample of about 625,000 families in the thirty-two cities studied and by progressive reduction to select from it a final controlled sample of approximately 30,000 cases. This was accomplished as follows:

(1) Only very general and easily obtainable information such as nativity, color, family composition, and housekeeping arrangements, was obtained from a random sample of the total family population of the selected communities. This information was recorded by the field agent on a *Record Card* for every one of the 625,000 families visited.

(2) From a selected random sample of approximately 250,000 of the above families, information was obtained during the same interview on income, occupation, composition of the family, type of living quarters, home tenure and rentals. These data were recorded on a *Family Schedule* obtained from all families which met certain eligibility requirements as to nativity, color, and family composition. In most cities this selected random sample was restricted to native white families containing both a husband and a wife. In New York City, Columbus, Ohio, and the South, native-born negroes were also included. In Portland, Oregon, Columbus, Ohio, and Chicago, Illinois, family schedules were also secured from single individuals.

(3) The selected random sample was supplemented by a stratified sample. This sample was needed to supply additional families of the higher income and rarer occupational groups from which the detailed data on expenditures could be obtained.

(4) The above samples were directed toward the final or controlled sample consisting of approximately 30,000 families which were asked to give the detailed information on consumption.

Thus the core of the study is this final sample of expenditure schedules controlled with respect to the factors which on *a priori* grounds are considered most significant in determining consumption

habits. The main controls are nativity and color, occupation, income and family type. In addition the families must satisfy certain minor eligibility requirements as regards length of residence in the city, roomers and boarders, etc., introduced to eliminate extreme cases which would blur comparisons.

The controlled sample of expenditure schedules was planned in such a way as to avoid the concentration of cases in the modal groups, and to yield the same number of cases for each income class, for each family type in each occupational group. This distribution assures a more adequate number of cases for analysis of the expenditures of families belonging to the upper income and rarer occupational groups.

Such a controlled sample has several distinct advantages. Aside from the economy resulting from the elimination of the concentration of the cases in the modal groups, the controls assure a homogeneous sample and make it possible to "hold other things equal" while the effect of a given factor is investigated. Thus it will be possible to study changes in expenditure patterns with increase in income, holding occupation and family type constant. Furthermore, the even distribution of the observations in a controlled sample results in a smaller standard error of the regression coefficient than would have been obtained from a random sample of the same size. This is an important consideration since it is planned to employ regression lines in the analysis of the data.

The disadvantage of a controlled sample, on the other hand, lies in the fact that the groups of families cannot be combined without being properly weighted. If grouping of controls is desired, or when more cases are needed for analysis of specific expenditures, it is necessary to weight the averages or aggregates before combining them. Weighting is also necessary before the total consumption of a specified item or of groups of items can be obtained. The random sample supplies these weights for the controlled sample.

From the discussion of the character of the sample, let us turn now to the sources and methods employed in the selection of the four samples and to the problems encountered in the collection of the data from the families chosen for each sample.

THE RANDOM AND SELECTED RANDOM SAMPLE

Problems Arising in the Process of Selecting the Families. Since the selected random sample was secured at the same time as the completely random sample, both samples may be considered together. Theoretically, it would have been best to complete the random sample

first. After sorting the *Family Schedules*, thus obtained into the desired breakdowns, it would have been a simple process to select the controlled sample. This procedure has, however, the following practical disadvantages:

(1) Since great uncertainty existed regarding the duration of the project it was necessary to be prepared for an early closing down of the survey. In this event, only income schedules and no expenditure schedules would have been collected.

(2) A time lag of several months between income and expenditure schedules would have been introduced. Aside from the fact that the housewife may lose interest, families move and cannot be located after several weeks have passed.

It was decided, therefore, to break up the total random sample into several subsamples, each of which was again a random sample. Selecting and obtaining a random sample of families in thirty-two cities of widely divergent sizes and with relatively untrained personnel supervising and carrying on the field investigation, made administrative considerations of paramount importance in the determination of the sampling techniques to be used.

The procedure adopted had to be such that instructions could be issued from the Washington office to city supervisors who in turn instructed field agents who knew relatively little about sampling. The technique and instructions, therefore, had to be as simple and as uniform as possible for all cities. It was likewise essential that the Washington office maintain careful control of the progress of the sample so that the procedure would be uniform throughout all cities covered by the investigation. It was imperative also, that the local office keep an exact record of the addresses assigned and visited to prevent the agents from following the line of least resistance by visiting only the most accessible families such as those residing on the first floor, those at home at the first visit, or those living near street car lines. Since a series of random samples was drawn in each city, it was necessary to keep a careful control of the addresses visited so that a given family would be drawn in only one sample.

In view of the above considerations, the selection of the sample in the *office* rather than in the *field* was deemed advisable. The choice of the source or list of names or addresses from which to draw the random sample constituted a real problem. The list used had to meet the requirements of availability, completeness, and accuracy of listing of the entire family population or of all dwelling units, up-to-dateness, and cheapness.

Sources Used. It was found that in most of the cities which were selected, city directories contained as complete a cross-section of dwelling units as could be found. All cities with the exception of Chicago and New York had recent city directories containing lists of dwelling units. Since a recent directory was not available for Chicago, the sample for this city was drawn from the 1934 C. W. A. Census of Population. In the case of New York, the City Directory had been found wanting in completeness and accuracy by research bodies which had tried to work with that source of information; the 1935 Real Property Inventory tested higher in this respect and was therefore used as the basis for the New York City sample. In all cities using directories the sample was drawn from the *street index* of dwelling units rather than from the *alphabetical name list.*

Generally speaking, investigation showed the directories to be complete and accurate in the listing of every dwelling unit, including vacancies.

In those cities in which directories were dated prior to 1934, building permits issued since 1934 were sampled to bring the sample of dwelling units up-to-date. The directory was found to be incomplete in Atlanta, Georgia, where a number of houses located in alleys and inhabited by negro families were not listed. These streets and alleys were canvassed and a sample of these addresses was added to the directory sample.

The instructions sent to the local offices for drawing the samples from the list of street addresses in the directory included a page from a directory with an illustration of the method to be used. In large cities (with populations of approximately 250,000) every twenty-fifth dwelling unit was drawn for the first sample. In middle-sized cities (with populations of approximately 50,000 persons) one in ten dwelling units was drawn for the first sample, and in small cities (with populations of about 15,000) the first sample covered one in every four dwelling units. The size of the final sample varied in the different communities depending upon the size of the city and the number of cases available for expenditure schedules. In most small cities complete coverage was made while in metropolitan and large cities the final random sample ranged from 4 to 80 per cent of the families. A directory card was prepared for each address drawn. The householder's name, so selected, as well as the floor or apartment number was written on the directory card. These directory cards were classified by census enumeration districts and the number falling into each district was forwarded to Washington for analysis. The same procedure was fol-

lowed for all subsequent samples so that consistency from one sample to another as well as the proportion of families drawn in each district in each sample could be checked at headquarters.

If an address marked in the directory as a business place or a vacancy was drawn, a directory card was prepared and a visit made to the address in order to include families living in the rear of stores, and families which had moved into places vacant at the date of the directory compilation. Instructions to field agents covered cases where the address visited was occupied by a different householder from the one listed in the directory, cases where the address listed as vacant was found to be occupied, and places listed as business buildings which were found to house families.

In New York City where every twenty-fifth dwelling unit was selected from the Real Property Inventory, the problems were very similar except for the fact that the inventory did not contain the names of the families so the agents had greater difficulty locating the specific dwelling unit to be visited. This disadvantage, however, was offset by the fact that the Real Property Inventory records included information on rent or home valuation of each dwelling. This information on rent facilitated the field work because the best field agents could be assigned to the higher income families which were more likely to refuse less qualified agents. Even more important was the use of these rent data for analyzing the biases in the sample resulting from refusals and from schedules with incomplete information. The Real Property Inventory was also useful because it furnished summary sheets of the population data for each tract, thus making it possible to compare the sample with the universe for a number of population characteristics.

The random sample of Chicago addresses was drawn from the block sheets of the 1934 C. W. A. Census. One in every ten households was drawn. Unlike the Real Property Inventory of New York City, or the street index of the city directories, the Census list did not yield a sample of all *dwelling units*. The Chicago Census represented a list of *families* rather than of *dwelling units*. Vacancies were therefore not listed and it was necessary to substitute another dwelling unit if the one drawn proved to be vacant. Since it was not permissible, according to Census regulations, to record the names of the householders, and since apartment numbers were not given, detailed instructions were issued to agents on the procedure to be followed in selecting the correct dwelling unit in multiple-dwellings.

The Chicago Census was not as complete or as accurate as was de-

sirable. Aside from errors in addresses, and duplicate listings of families, a number of tract books were missing. It was assumed that the incorrect listings were randomly distributed and did not disturb the randomness of the sample. The omission of certain tracts, however, might have introduced a real bias in the sample. Selection of the 10 per cent sample from these omitted tracts, therefore, was made in the field by the agents. A careful control of the field sampling was possible since agents kept records of the number of families in each building in the block and of the particular dwelling units drawn for the sample. Field production when the sampling was done in the field proved to take about a third longer than when the sample was selected in advance of the field assignment. However, the office time taken to draw the sample from the census was eliminated. Despite the above limitations of the census it is felt that with the precautions taken, the Chicago sample is a satisfactory random sample of the city.

Problems Arising in the Process of Collection. Thus far we have discussed the selection of the families to be interviewed. While this is recognized as a very important part of sampling procedure, it should be pointed out that random selection is no guarantee that a random distribution of cases will be collected finally. Sampling theory is usually concerned with results obtained from a random selection of black and white balls from an urn on the assumption that the experimenter has no difficulty pulling the balls out of the urn. Unfortunately for social scientists, human beings do not behave like balls in an urn. Some very real problems of sampling arise in the process of collecting data from the families selected at random.

Paramount among the problems encountered in the field are refusals, the inability of families to give the desired information, and unsuccessful attempts to contact families.

Both preventive and corrective measures were adopted to meet the problems of refusals and of failures to contact families. Incomplete schedules and refusals are largely due to the approach used by the field agent, so the best preventive measures are directed at a careful training of agents and control of assignments. Calls at night to interview someone other than the person refusing, eliminating those agents who turn in too many refusals, shifting unsuccessful agents from the more difficult districts to the sections where families are more cooperative, reduced refusals. The agents in the present study were instructed to make at least two calls upon families before turning in the cards with partial or no information. Assignment supervisors were instructed to assign cases for a third visit to different and more skilled

agents. Another control of the work of the agent was exercised through *check interviewing* which made it possible to discover agents who reported vacancies when families refused information. It was claimed by some supervisors that emphasis on speeding up production would increase the number of incomplete and unacceptable schedules. This was not found to be the case, however. In fact, the most productive agents also had the fewest refusals, and the most accurate schedules. A third important preventive measure consisted in securing favorable presentation of the investigation in the press.

Corrective methods in assuring the collection of the random sample as selected, consisted in measuring the biases introduced by refusals, incomplete schedules, and cases where families could not be contacted. The first analysis of any possible biases was made by finding the proportion of refusals and uncontacted cases in each district. Early reports indicated that a significant number of families in the wealthier neighborhoods were not at home or refused to give the information requested. During the hottest weeks of the summer months as many as 50 per cent of the families in the better districts of the large cities had left the city and moved to vacation places. It was possible to revisit these families upon their return to the city in the fall after the early analysis had revealed the need for revisits.

The analyses of occupations of uncooperative family heads provided another measure of the biases introduced by refusals. The occupation listed in city directories, supplemented in small cities by information supplied by staff members who were acquainted with many families, made possible the analysis of the proportion of refusals and uncontacted cases in each occupational group. A preliminary analysis, prepared before the final work on "reclaiming" had been completed, indicated that refusals and uncontacted families were less than half as frequent, proportionately, among wage earners as among other occupational groups. Clerical and salaried professional persons showed the next smallest percentage of refusals, while families of business and professional persons working on their own account had the highest proportions of refusals. This is partly due to the fact that business and family accounts often are not kept separately and, therefore, it is often too difficult for persons working on their own account to report the information on family income and expenditures in the desired form.

The analysis of the distribution of refusals and uncontacted cases by rent groups was possible in New York City where the Real Property Inventory provided rent data for every dwelling unit. A preliminary

tabulation of these cases revealed a concentration of unsuccessful cases in the upper rent groups. Unacceptable or incomplete schedules were approximately twice as frequent in the rent groups over $50, (in proportion to the total number of families in this group), as in rent groups under $50 per month. A further attempt to measure the bias introduced by schedules which were unacceptable will be made for partially completed schedules in all communities.

Having analyzed the type of bias in the sample, the need for reclaiming the cases in the upper income and rarer occupational groups became apparent. Experience taught us that the best agents could successfully reclaim many of the families reported as uncooperative by the original agent. A "recapture" program was instituted, therefore, in all cities and it is expected that the percentage of refusals and incomplete schedules will be reduced considerably.

Supervisors were instructed to assign for recapture a sufficient number of cases in the less frequent occupational groups to reduce the final proportion of unsuccessful cases to that found in the wage earner families. Thus in the end the refusals and incomplete group should be randomly distributed with respect to occupation—one of the controls for the controlled sample.

Since time and funds were limited, the relatively extensive and time consuming recapture program was supplemented in cities with limited coverage by a provision for the substitution of a neighboring family for the family refusing information. The regular agents were not permitted to make the substitutions since the supervisors felt that this would have caused them to place less effort than was desired on obtaining the assigned cases. The instructions for substitutions were so drafted that only "similar income" families were contacted for substitutions.

If the recapture and substitution program did not equalize the proportion of refusals in all occupational groups, it is possible to estimate the influence the omitted cases would have exerted on the occupational or income distribution had they been included. These estimates will be based on the data on the relation between rent and income, and occupational distribution by districts.

THE STRATIFIED SAMPLE

Insofar as possible, the families giving the detailed expenditure schedule information were to be drawn from the random sample. The random sample was planned not only to give adequate weights for the controlled sample, but to yield approximately 80 per cent of

the cases needed for the expenditure schedules. Generally speaking the wage earners and clerical groups were found in sufficient numbers in the random sample to yield the required number of expenditure schedules. The salaried and independent professional and business groups, however, did not occur in the random sample in sufficient numbers to fill the required cells. It was necessary, therefore, to draw these needed cases from outside the random sample or from the "stratified sample." The procedure adopted was two-fold. First, in certain of the large cities such as Denver, and Atlanta, it was found that the rarer occupational groups were concentrated in a few districts of the city. Thus, by taking a larger or more intensive random sample of these districts than in the other sections of the city, the desired number of cases eligible for expenditure schedules were obtained. In other large cities, the needed upper income groups were drawn from suburbs which were essentially parts of the cities studied, but which were not included in the random sample because of the difficulties which would have been encountered when testing the sample against Census and other data for the city. In Columbus, Ohio, for example, the stratified sample was drawn from the suburb of Bexley, which is surrounded by the city proper. City supervisors were cautioned not to rely entirely upon the cases yielded by these districts since there was danger of producing a bias in the expenditure data of the upper income groups by including too many families living in the same area, paying similar rents, and probably having other similar expenditure patterns.

List sampling constituted the second procedure used for obtaining the additional cases in the stratified sample. The list of families in the rarer occupational groups was compiled from numerous sources such as lists of professional people, business executives, store owners, etc. The specific occupations represented in the list were chosen so as to be as similar as possible to groups occurring in the random sample. Supervisors were cautioned not to overload the list with telephone subscribers. Considerable work was involved in checking over the addresses drawn by list sampling with those already found in the random sample in order to avoid contacting the same family more than once. List sampling did not prove to be very successful. This may be attributed to two factors. In the first place, the random sample was so large that as many as 60 per cent of the families in the city had been contacted before the list sampling began. Thus, the problem of weeding out the uncontacted families involved considerable clerical work. A second reason for the lack of success of the list sampling may

be attributed to the difficulty of finding families which met the requirements of three controls. It proved to be almost impossible to find by list sampling methods cases of the correct income, occupation, and family types needed for expenditure schedules. In Omaha, for example, where a 32 per cent random sample had been made, less than 5 per cent of the names assigned from lists yielded completed and needed expenditure schedules.

THE CONTROLLED SAMPLE

It was pointed out above that the core of the study is a controlled sample of families giving detailed information on expenditures. This sample was selected according to a pre-arranged plan, which specified the number of cases desired for each final breakdown or "cell." Since the number of cases in these final breakdowns is small, it was of paramount importance to obtain randomness in the selection of families for these "cells." Great care was therefore taken to guard against the introduction of a bias. Even the first small random sample yielded all the desired cases for the most frequent population groups. If the cells drawn from the modal population group had been filled from the first sample, they would have been much more homogeneous with respect to the period covered by the data than cells which represent the less frequent population groups, and any greater variability within the latter cells might have been attributed to income or occupation while it might actually have been due to price changes occurring while the study was in progress. This possible bias was minimized by the provision that not more than 50 per cent of the cases in cells representing the most frequent population groups were to be chosen from one sample and that all expenditure schedules which were discarded later because income and expenditures did not balance should be replaced by cases drawn from recent samples. It is recognized, however, that these provisions did not entirely eliminate the bias introduced by the time element.

Regarding the problems of collection, it is not so much the *unwillingness* as it is the *inability* of the family to give the information, which makes the maintenance of a random selection of families for the controlled sample so difficult. There are certain technical difficulties inherent in the underlying principles of the study itself which affect the selection of the cases in the controlled sample. The more important of these is the requirement that receipts and disbursements of the family over the year must balance within 5 per cent. Those schedules which do not balance are unacceptable. It has been shown in previous

studies of family expenditures that the more intelligent and the more thrifty persons are most likely to keep records, and therefore are able to account for income and expenditures most accurately. Thus a bias may be introduced in the controlled sample of families giving acceptable schedules. In order to guard against this bias, the best field workers are used for expenditure schedule work, in order to secure from the family complete and acceptable expenditure information. Revisits, telephone calls to the family to clear up missing items, and interviewing the husband are necessary to make schedules acceptable but these procedures are preferable to discarding schedules.

At the present stage of the investigation, it was necessary to emphasize the administrative problems encountered in collecting the samples. We feel that the problems are not unique to this Study, but are encountered to a greater or less extent in most studies of social phenomena. The final appraisal of the techniques used will be made at a later date when the samples have been tested against the universes from which they are drawn.

CONSISTENCY OF RECORDING STATISTICAL DATA FROM PRISON FILES*

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All who work with sociological data are aware of the difficulties met in classifying sociological phenomena according to a set scheme which is essential for statistical analysis. Often when we attempt to measure the margin of error in categorization, we are surprised to find how serious it is with regard to certain social phenomena such as family relationships or social type. Inquiry into the accuracy and biases of recording and classification is a neglected but very important field for research.

In the criminological field this problem was fully appreciated by George B. Vold,[1] who attempted to ascertain the consistency of his classifications; first, by a reclassification of 198 cases eight weeks after the first entries had been made, and, secondly, by having another investigator make an independent classification of 63 of these same cases. In some items the percentage of agreement between the first and second classification was as high as 97 ("use of drugs") or 92 ("outcome of parole"). In other items, as "social type of inmate," the percentage was as low as 50.

The classification made by Vold and that made by a graduate student were, in general, somewhat less consistent than those obtained by the two recordings of Vold.

In another study of a similar nature by Tibbitts,[2] a reclassification of 907 parolees used in Burgess's classical study[3] showed appreciable inconsistencies, the percentage of error ranging from 1 for "nature of sentence" to 39 for "work record." In 39 per cent of the cases, the classification of an individual with respect to work record differed from the original classification of that individual made from the same record and according to the same scheme of classification.

The present study of consistency in recording was undertaken in connection with the nation-wide study initiated by the Attorney General of the United States and financed by WPA funds. The samples

* A paper presented at the Ninety-eighth Annual Meeting of the American Statistical Association (at a joint session with the American Sociological Society), Chicago, December 28, 1936.

[1] Vold, George B., *Prediction Methods and Parole*, Sociological Press, Minneapolis, Minn., 1931.

[2] Tibbitts, Clark, "Reliability of Factors Used in Predicting Success or Failure in Parole," *Journal of Criminal Law and Criminology*, vol. XXII, no. 6 (March 1932), p. 844 et seq.

[3] Bruce, Burgess, Harno, and Landesco, "Parole and the Indeterminate Sentence—the Workings of the Indeterminate Sentence Law and the Parole System in Illinois," *Journal of Criminal Law and Criminology*, vol. XIX (May 1928), pp. 239–286.

analyzed in this study are based on data taken from the records of persons released provisionally from Federal institutions during the period 1930 to January 1, 1936, and whose provisional release terminated, successfully or unsuccessfully, within the same period.

In view of the fact that this study is being carried on largely by relief workers, most of whom have no technical training in sociology, statistics, or allied branches of learning, it was felt especially imperative that the consistency with which information was being transcribed from the files onto our statistical schedules be determined with a reasonable degree of precision. Aside from this primary consideration, there were a number of secondary objectives justifying a careful study of the degree of this consistency.

In comparison with the studies of Vold and Tibbitts, there are certain distinctive features of this study which should be noted. The most important is that the consistency of many more items was determined than in the former studies. A second distinction is that larger samples were used than in the former studies. Thirdly, consistency was measured in *three* separate samples, taken at different periods during the recording of the 25,000 Federal cases, thereby giving a measure of the improvement in consistency that can be brought about by training a group such as the one which carried on this study. Fourthly, recordings and re-recordings were done by a group of relief workers under the personal supervision of young men selected on the basis of general ability, but without any special sociological or statistical training, a lack which was compensated for by providing very detailed instructions to each worker. Finally, each recording of the samples was made by a different group of people, the members of which, working independently, recorded in each case the entire schedule.

In setting up groups in Washington to record the schedules for Federal cases, one person with two assistants was assigned to the files to remove the jackets (prison records) for each institution and to allocate these jackets daily to the eight supervisors. Each supervisor had assigned to him from five to seven relief workers, who were seated around a long table at the head of which sat the supervisor.[4]

Each group had assigned to it one, two or three Federal institutions, and each individual worked only with jackets from one Federal institution, even if more than one institution was assigned to his table. This arrangement was made so as to make it possible for each recorder to become thoroughly familiar with one set of jackets and thus lessen the likelihood of errors.

[4] These supervisors after their training in Washington were eventually sent into the field as regional field supervisors.

Each morning the supervisor distributed three or four jackets to each of the workers assigned to him and before noon these jackets and the completed schedules for them were returned to the supervisor for verification. The same procedure was followed in the afternoon. Each recorder was given a number which he placed on every schedule that he completed, so that errors could be called to his attention and the number of schedules and of errors per schedule could be recorded on a daily individual output sheet. The schedules were then verified by the supervisor and the jackets returned to the person in charge of the files. The work of the supervisors was checked on the basis of sample schedules selected at random from each group after they had been recorded and verified.

When the first 2,000 Federal schedules had been completed, the assignment of institutions to the various tables was completely changed and the first 500 recordings were recorded a second time. The change in assignment of institutions to tables made it certain that no person recorded or verified a schedule for the same individual inmate a second time. The preliminary analysis of this first re-recording was used to eliminate certain items in which the inconsistency was altogether too great and to clarify portions of the instructions where the consistency analysis showed that greater sharpening and precision of definition was necessary.

These first 500 cases constitute the first sample by which the degree of consistency was determined. When 10,000 Federal schedules had been recorded, once more the assignment of institutions to different tables was changed and the last 501 of these cases were re-recorded. Again, no individual recorded or verified the same schedule he had done previously. It may be mentioned that at no time were either the supervisors or the recorders informed ahead of time when a new re-recording was to be initiated.

When 23,000 Federal schedules had been recorded, the assignment of institutions to different tables was changed a third time and a third sample of 500 cases was re-recorded. Subsequently, when all the Federal cases were completed, this last sample of 500 cases was recorded a third time, but this last recording will not be dealt with here.

The classifications of cases by the first and second recording were analyzed for each of 124 items, such as race, marital status, number of children, and criminal record. In the analysis of the first sample, in addition to percentage of error, the coefficient of contingency was also determined, as well as the chi-square value when the distribution derived from the first recording was compared with the distribution obtained from the second recording. The results confirmed the earlier

deduction based on theoretical considerations; that contingency coefficients are of little significance in an analysis of this nature.

TABLE I

LENGTH OF SENTENCE

Analysis of the Third Sample

First recording	Second recording								
	X0	X2	X3	X4	X5	X6	X7	X	Total
X0 20 years and over	1								1
X2 6 months–1 year, 1 day		90	3						93
X3 1 year, 2 days–1½ years		1	77						78
X4 19 months–2½ years				161					161
X5 31 months–4½ years					154				154
X6 55 months–5½ years						12			12
X7 67 months–9 years							1		1
XX Unknown									
Total (3rd sample)	1	91	80	161	154	12	1		500
Average percentage		98	97	100	100	100			99.2

Aggregate of All Three Samples

First recording	Second recording								
	X0	X2	X3	X4	X5	X6	X7	XX	Total
X0 20 years and over	2								2
X2 6 months–1 year, 1 day		436	8					1	445
X3 1 year, 2 days–1½ years		7	385		2				394
X4 19 months–2½ years			2	351	1				354
X5 31 months–4½ years				1	249	1			251
X6 55 months–5½ years					1	50			51
X7 67 months–9 years							4		4
XX Unknown									
Total	2	443	395	352	253	51	4	1	1501
Average percentage		98	98	99	99	98			98.4

Summary Values

	I	Total in diagonal	Percentage of agreement	% S. E.	Fiducial limits when $P = .01$	
					Upper	Lower
First sample	9	485	97.0	.77	98.96	95.04
Second sample	25	496	99.0	.45	100.00	97.87
Third sample	31	496	99.2	.40	100.00	98.17
Aggregate (all samples)	48	1477	98.4	.32	99.22	97.58

The chi-square analysis showed, as had been expected, that, despite appreciable percentage deviation, the general distributions obtained from the two recordings were homogeneous; that the statistics derived

from these two recordings were not significantly different. In the analysis of subsequent samples, the computation of contingency coefficients and the chi-squares for the distributions were discontinued.

Table I, dealing with length of sentence, shows the comparative analysis of the third sample. The vertical frequencies give the distribution of cases according to the second recording, while the horizontal frequencies show the distribution resulting from the first recording. The frequencies in the diagonal represent cases in which both the first and the second recorders were in perfect agreement. As this item is one in which the percentage of agreement was very high, the comparative analyses of samples one and two are essentially identical with that given for sample three.

It will be noted that the first recorders found 93 cases having a sentence of six months to one year and a day. The second recorders reported 91 such cases. In 90 cases, the classifications of the first and the second recorders were identical. Of persons with a sentence of one year and two days to one and one half years, 78 cases were reported by the first recorders, 80 by the second, and in 77 of these cases both groups of recorders were in agreement.

The percentages given in line with the caption, "average percentage," are obtained by adding the frequencies in corresponding columns and rows and dividing twice the frequency found in the diagonal by this sum. It gives an approximate percentage of agreement between two groups of recorders with respect to cases falling in a particular column and row.

The aggregate table combining all the three samples has the same significance; out of 1,501 cases, the first recorders found 445 with a sentence of six months to one year and a day, and the second recorders reported 443 such cases. In 436 of these cases both groups of recorders were in agreement.

The statistics obtained from the analyses of these samples are shown in the summary values for Table I. I, the amount of information obtained from each sample, is equivalent to the expression, $n/(pq)$, where n is the number of cases considered, p is the probability of a case being within the diagonal, and $q=1-p$. This function is the reciprocal of the variance and its significance is explained by R. A. Fisher in *The Design of Experiments*. S. E. is the standard error in terms of percentages, and the fiducial limits give the probable range of variation of percentages of cases in the diagonal with a probability of .01.

It should be stated in this connection that the various samples were combined only after testing their homogeneity. In a number of in-

TABLE II
COMMUNITY: PAROLE RELEASE

First recording	Second recording												
	1	2	3	4	5	6	7	8	9	0	V	X	Total
First Sample													
1 500 or more	79	3		1	1	1	1	2			1		89
2 250–499	1	38	1			1							41
3 100–249	1		30							1			32
4 50–99	1			21									22
5 25–49	3		2	1	24					1			31
6 10–24	3			1		30		1		1		1	37
7 5–9	2						15	1	1	1			20
8 2.5–4	2			1				19		1			23
9 1–2.4	1	1	1			1	1	2	58	2	1	3	71
0 Counties	4		2	1	1	1	1		4	93		1	108
V Inapplicable	1										19		20
X Unknown										1	2	3	6
Total	98	42	36	26	26	34	18	25	63	101	23	8	500
Average percentage	84	92	88	87	84	84	79	79	87	89	88	43	85.8
P of chi-square	.46	.91	.62	.55	.49	.71	.74	.76	.46	.59	.64	.59	
Second Sample													
1 500 or more	55		1	2					1				59
2 250–499		77					1			3		1	82
3 100–249	1		25				1			2	1		30
4 50–99				41									41
5 25–49					14		1			1			16
6 10–24						33			1	4		1	39
7 5–9		1				1	24						26
8 2.5–4				1				9	1	1			12
9 1–2.4			1	1					30	4			36
0 Counties		1					2		3	115	3	1	125
V Inapplicable											28		28
X Unknown	1	1			1						1	3	7
Total	57	80	27	45	15	34	29	9	36	130	33	6	501
Average percentage	95	95	88	95	90	90	87	86	83	90	92	46	90.6
Third Sample													
1 500 or more	49						1				1		51
2 250–499		61	2					1		1			65
3 100–249		1	31						1			1	34
4 50–99				27						1			28
5 25–49				1	30								31
6 10–24						23				3			26
7 5–9							32		1	2			35
8 2.5–4				1				19		5			25
9 1–2.4						1			25	2			28
0 Counties		1	1	2	3	4	4	2	7	135			159
V Inapplicable											17		17
X Unknown							1						1
Total	49	63	34	31	33	28	38	22	34	149	18	1	500
Average percentage	98	95	91	91	94	85	88	81	81	88	97		89.8

TABLE II (*Continued*)

First recording	Second recording												
	1	2	3	4	5	6	7	8	9	0	V	X	Total
Aggregate													
1 500 or more	183	3	1	3	1	1	2	2	1		2		199
2 250–499	1	176	3			1	1	1		4		1	188
3 100–249	2	1	86				1		1	3	1	1	91
4 50–99	1			89						1			96
5 25–49	3		2	2	68		1			2			78
6 10–24	3			1		86		1	1	8		2	102
7 5–9	2	1				1	71	1	2	3			81
8 2.5–4	2			3				47	1	7			60
9 1–2.4	1	1	2	1		2	1	2	113	8	1	3	135
0 Counties	4	2	3	3	4	5	7	2	14	343	3	2	392
V Inapplicable	1										64		65
X Unknown	1	1			1		1			1	3	6	14
Total	204	185	97	102	74	96	85	56	133	380	74	15	1501
Average percentage	91	94	89	92	89	87	85	81	84	89	92	41	88.7

Summary Values

	I	Total in diagonal	Percentage of agreement	% S. E.	Fiducial limits when $P = .01$	
					Upper	Lower
First sample	2	429	85.8	1.56	89.82	81.78
Second sample	3	454	90.6	1.31	93.97	87.27
Third sample	3	449	89.8	1.35	93.28	86.32
Aggregate (all samples)	8	1332	88.7	.82	90.85	86.63

stances the criterion of homogeneity used was a P of .05, while in others a less rigid criterion, $P = .01$, had to be used. In those samples where the homogeneity fell below .01, no combinations were made.

Table II represents items with a medium degree of agreement between the first and the second recording. Thus, in the first sample the percentage of agreement is 85.8, which means that in 85.8 per cent of the cases both groups of recorders made identical classifications, these being represented by the frequencies found in the diagonal. In the second sample this complete agreement holds true in 90.6 per cent of the cases, and in the third sample in 89.8 per cent. The summary analysis for these three samples is also shown.

The percentage of agreement between the two recordings for the entire 1,501 cases is 88.7. It may be noted here that the greatest error in this table is in connection with the "unknown" column. This would suggest that probably a good share of the error was made by the coders and not merely by the recorders. The item (Community: Parole Re-

lease) refers to the size of the community (in terms of population according to the 1930 census) to which the subject was sent at the time he was granted his provisional release. The recorders were required to give the name of the town and of the state, and the coders, with the aid of a gazetteer, were to find the population of these cities and towns, and to code them accordingly. Except in the category "unknown," the agreement in most of the other columns and rows is appreciably higher than the aggregate percentage of agreement, 88.7, would indicate.

The third table (Table III) shows the average monthly earnings in the last job, one of the least consistent items. In the first sample the percentage of agreement is only 49.4, in the second sample, 52.3, and in the third sample, 62.4. All of these percentages are decidedly lower than the agreements obtained for most of the other items. In this item the chi-square analysis of the three samples indicates a lack of homogeneity between the three samples. Only the first and second samples are homogeneous according to this criterion. The summary table, therefore, shows only this combination. In this table the fiducial limits were computed with $P = .05$ as a basis.

An analysis similar to that represented by the three tables described above was made for each of the 124 items on the schedule. Table IV summarizes the results of this analysis for 63 of the 124 items.[5]

This summary table shows in the first column the items studied arranged in five major groups, namely, parental background, personal, criminal, institutional, and parole history. Column 2 shows the percentages of agreement between the entries of the first and the second group of recorders for the third sample of 500 cases. In column 3 are found the corresponding percentages obtained from the second sample, and in column 4 those derived from the first sample. Column 5 shows the agreement either for two or for three samples in combination. All samples were tested for homogeneity and were combined only where the criterion of homogeneity did not fall below .01. In column 6 is given the amount of information, the significance of which has already been explained. The amount of information applies to the aggregate of the samples shown in column 5.

In many instances the homogeneity would be demonstrated, even though a P of .05 were to be used as the criterion. In cases where the test of homogeneity indicated that all the three samples were not homogeneous, two of the three samples were combined using the same

[5] Dr. Sanders' manuscript was submitted for publication with the full list of 124 items, but in the interests of economy the Editor reduced the table to a single page by deleting half of the items. Among the items that were deleted were those whose precise meaning was not very apparent without further explanation. The distribution of percentages of agreement for the items eliminated was quite similar to that for the items retained. The full list may be secured from the author.—*Ed.*

TABLE III

AVERAGE MONTHLY EARNINGS LAST JOB

First recording	Second recording												
	1	2	3	4	5	6	7	8	9	0	V	X	Total
First sample													
1 Under 20	3	1					1				1	4	10
2 20– 49	3	10	2	2	1	1			1		1	4	25
3 50– 79	1	6	41	12	1		1		1		1	6	70
4 80–109		1	4	32	8	4	2	1	4			6	62
5 110–139			1	3	14	7	1	1	2			7	36
6 140–169			1		1	8	1	1				9	21
7 170–199		2	3	1		2	7		2			1	18
8 200 and over		1	1	2		2	3	14				3	26
9 Own account or commission		1	3	3	1	1	1	3	20			12	45
0 None		1	2		1							1	5
V Inapplicable							2			1	3	2	8
X Unknown	5	7	16	9	3	2	3	2	28	2	2	95	174
Total	12	30	74	64	30	27	22	22	58	3	8	150	500
Average percentage	27	36	57	51	42	33	35	58	39		37	59	49.4
P of chi-square	.67	.49	.72	.85	.45	.37	.52	.46	.18	.50	1.00	.10	
Second sample													
1 Under 20	1	1							1		1		4
2 20– 49		11	5	2	1				3		4	5	31
3 50– 79		4	16	7					1		7	11	46
4 80–109			3	22		2			1		3	5	36
5 110–139			1	3	11				2		1		18
6 140–169				2		15			3		1	2	23
7 170–199							2					1	3
8 200 and over				1	1		1	10	3		1	1	18
9 Own account or commission				1	1	1			23		14	11	51
0 None													
V Inapplicable	1	2	6	1	1	2		2	9		95	29	148
X Unknown	1	3	7	4			2	1	14		35	56	123
Total	3	21	38	43	15	20	5	13	60		162	121	501
Average percentage		42	38	56	67	70		64	41		61	46	52.3
Third sample													
1 Under 20													
2 20– 49											1	6	7
3 50– 79								1				2	3
4 80–109				2			1		1		2	7	13
5 110–139				1	5	1					1	4	12
6 140–169					1	3	1				1	1	7
7 170–199							6				1	2	9
8 200 and over								2			1	1	4
9 Own account or commission								1	36		17	24	78
0 None													
V Inapplicable			1					1	13		38	20	73
X Unknown			2	3	1	4		1	23		40	220	294
Total			3	6	7	8	8	6	73		102	287	500
Average percentage				21	53	40	71	40	48		43	76	62.4

TABLE III (*Continued*)

First recording	Second recording												
	1	2	3	4	5	6	7	8	9	0	V	X	Total
First two samples													
1 Under 20	4	2					1		1		2	4	14
2 20– 49	3	21	7	4	2	1			4		5	9	56
3 50– 79	1	10	57	19	1		1		2		8	17	116
4 80–109		1	7	54	8	6	2	1	5		3	11	98
5 110–139			2	6	25	7	1	1	4		1	7	54
6 140–169			1	2	1	23	1	1	3		1	11	44
7 170–199		2	3	1		2	9		2			2	21
8 200 and over		1	1	3	1	2	4	24	3		1	4	44
9 Own account or commission		1	3	4	2	2	1	3	43		14	23	96
0 None		1	2		1							1	5
V Inapplicable	1	2	6	1	1	2	2	2	9	1	98	31	156
X Unknown	6	10	23	13	3	2	5	3	42	2	37	151	297
Total	15	51	112	107	45	47	27	35	118	3	170	271	1001
Average percentage	28	39	50	53	50	50	37	61	40		60	53	50.8

Summary Values

	I	Total in diagonal	Percentage of agreement	% S.E.	Fiducial limits when P = .05	
					Upper	Lower
First sample	1	247	49.4	2.24	53.77	45.03
Second sample	1	262	52.3	2.23	56.67	47.93
Third sample	1	312	62.4	2.17	66.65	58.15
First and second	2	509	50.8	1.58	53.95	47.75

criterion. The combinations are indicated by symbols explained at the end of the table. For all items, the number of cases included was 500 for the third sample, 501 for the second, and 500 for the first. However, in a few items, the questions were not applicable to all of the 500 cases. These items, in which the number of cases is less than 500, are indicated by an asterisk.

Table IV is to be interpreted as follows: The first item, race of father, shows in the third sample perfect agreement between the two groups of recorders in 98.8 per cent of the cases. That is, there were in the entire 500 cases only 6 in which the race designation given by the first group of recorders was different from that given by the second. The comparable percentage in the second sample was 97.8 with a standard error of .66 and in the third sample 97.4 with a standard error of .71. All the three samples were homogeneous so that for the 1,501 cases the percentage of agreement with respect to the race of subject's father was 98 with a standard error of .36. That is, there

TABLE IV—CONSISTENCY IN RECORDING DATA FROM PRISON FILES

Items recorded	Percentage of agreement ± 1 standard error				Amount of information
	Samples			Aggregate (a)	
	Third	Second	First		
1	2	3	4	5	6
PARENTAL BACKGROUND					
Race of father	98.8± .49	97.8± .66	97.4± .71	98.0± .36	38
Race of mother	98.6± .53	97.8± .66	97.8± .66	98.1± .36	40
Citizenship of father	95.0± .97	88.6± 1.42	79.8± 1.80	—	—
Religion of father	93.4± 1.11	92.6± 1.17	77.4± 1.87	93.0± .81c	8
Religion of mother	93.8± 1.08	91.8± 1.23	75.2± 1.93	92.8± .82c	8
Occupation of father	75.4± 1.93	74.0± 1.96	62.4± 2.17	74.7± 1.37c	3
Economic status parents	98.6± .53	87.4± 1.48	41.0± 2.20	—	—
Delinquency and criminality in family	90.8± 1.29	86.6± 1.52	85.8± 1.56	87.7± .85	7
Mental and nervous diseases in family	98.8± .49	97.6± .69	96.2± .86	97.5± .40	31
Size of parental family; own sisters	86.6± 1.52	69.5± 2.06	72.2± 2.01	70.8± 1.44d	2
Size of parental family; own brothers	88.4± 1.43	74.4± 1.95	63.8± 2.15	69.1± 1.46d	2
Size of parental family; other sisters and brothers	92.2± 1.20	82.6± 1.70	86.8± 1.52	89.5± .97b	5
PERSONAL HISTORY					
Birth date	96.6± .81	92.6± 1.17	91.0± 1.28	94.6± .71c	10
Birthplace	98.4± .56	97.4± .71	98.4± .56	98.1± .35	40
Birth rank	89.8± 1.35	78.4± 1.84	62.2± 2.17	—	—
Nativity	98.4± .56	98.2± .60	97.2± .74	97.9± .37	37
Habits	70.6± 2.04	51.9± 2.23	60.0± 2.19	55.9± 1.57d	2
Age at leaving school	85.6± 1.57	88.6± 1.42	83.8± 1.65	86.0± .90	6
Education	63.0± 2.16	80.0± 1.79	64.6± 2.14	63.8± 1.52b	2
Psychiatric classification	99.2± .40	80.8± 1.76	68.4± 2.08	—	—
Marital status	91.2± 1.27	90.4± 1.32	88.6± 1.42	90.9± .77	8
Age at first marriage	87.8± 1.46	87.6± 1.47	87.0± 1.51	87.5± .85	7
Number of children: own	95.6± .92	94.8± .99	92.0± 1.22	94.1± .61	14
Number of children: other	97.8± .66	97.6± .69	94.6± 1.01	96.7± .46	23
Number of dependents: minors	84.0± 1.64	82.4± 1.70	81.8± 1.73	82.7± .98	5
Number of dependents: adults	82.6± 1.69	76.2± 1.90	72.4± 2.00	79.4± 1.28c	3
*Occupation first pursued (male)	51.9± 2.29	54.3± 2.27	41.1± 2.27	53.1± 1.61c	2
*Occupation first pursued (female)	54.5± 10.62	58.8± 11.94	74.2± 7.86	64.3± 5.73	—
*Occupation, usual (male)	54.6± 2.28	55.2± 2.26	45.6± 2.30	51.8± 1.32	3
*Occupation, usual (female)	68.2± 9.93	47.1± 12.11	58.1± 8.87	58.6± 5.89	—
Number of months unemployed	48.2± 2.23	41.7± 2.21	46.2± 2.23	45.4± 1.29	3
Average earnings at last job	62.4± 2.17	52.3± 2.23	49.4± 2.24	50.8± 1.58d	2
CRIMINAL HISTORY					
Nature of first offense	74.6± 1.93	75.0± 1.94	73.8± 1.97	74.5± 1.13	4
Age at first arrest	80.2± 1.78	79.2± 1.81	68.6± 2.08	79.7± 1.27c	3
Disposition, first arrest	72.2± 2.00	67.1± 2.10	58.2± 2.21	69.6± 1.45c	2
Number of arrests	74.0± 1.96	61.7± 2.17	68.8± 2.07	71.4± 1.43b	2
Number of arrests without conviction	80.6± 1.77	75.0± 1.94	70.0± 2.05	77.8± 1.31c	3
Number of sentences to penal and correctional institutions	85.8± 1.56	75.0± 1.94	77.0± 1.88	76.0± 1.33d	3
Number of escapes	96.6± .81	95.6± .92	85.6± 1.57	96.1± .19c	13
Present offense	91.6± 1.24	96.0± .88	87.8± 1.47	89.7± .96b	5
Number of aliases	84.6± 1.61	80.6± 1.77	—	82.6± 1.20c	3
Plea entered	94.6± 1.01	94.4± 1.03	92.4± 1.19	93.8± .62	13
INSTITUTIONAL HISTORY					
Age when admitted to institution for present offense	95.8± .90	93.8± 1.08	87.2± 1.49	94.8± .70c	10
Length of sentence	99.2± .40	99.0± .45	97.0± .77	98.4± .32	48
Fine and / or costs	98.2± .59	97.4± .71	82.0± 1.72	97.8± .46c	23
Time served, present offense	97.6± .68	99.6± .28	94.8± 1.00	98.6± .37c	36
Offenses, institutional	88.8± 1.41	84.6± 1.61	85.4± 1.58	86.3± .89	6
Occupation in institution	83.4± 1.66	77.6± 1.86	68.6± 2.08	80.5± 1.25c	3
Work habits	84.6± 1.61	78.0± 1.85	70.0± 2.05	81.3± 1.23c	3
Judge and prosecuting attorney	80.8± 1.76	78.4± 1.84	61.4± 2.18	79.6± 1.27c	3
PAROLE HISTORY					
Mode of release	99.0± .44	99.4± .34	96.2± .86	99.2± .28c	63
Age at time of release	97.8± .66	93.0± 1.14	89.2± 1.39	91.1± .90d	6
Residence on parole	79.4± 1.81	81.4± 1.74	79.8± 1.80	80.2± 1.03	5
*Occupation, first (female)	81.8± 8.22	70.6± 11.05	80.6± 7.10	78.6± 4.90	—
*Occupation, longest (female)	86.4± 7.32	70.6± 11.05	77.4± 7.51	78.6± 4.90	—
*Occupation, first (male)	66.5± 2.16	65.5± 2.13	59.1± 2.27	63.7± 1.27	3
*Occupat on, longest (male)	66.9± 2.15	67.4± 2.13	59.9± 2.19	64.8± 1.26	3
Number o. visits of parolee to supervisor	83.6± 1.66	92.8± 1.16	62.2± 2.17	—	—
Number of visits of parolee to adviser	86.6± 1.52	57.3± 2.21	35.6± 2.14	—	—
Offense committed on parole	98.4± .56	99.0± .45	95.4± .94	98.7± .36c	39
Number of reincarcerations	98.2± .59	98.4± .56	94.6± 1.01	98.3± .41c	30
Parole dates, release	99.8± .20	99.2± .40	97.4± .71	99.5± .22c	101
Parole dates, termination	98.6± .53	99.2± .40	96.6± .81	98.1± .35	41

* Sample with fewer than 500 cases. a. Using P=.01 as standard of significance. b. First and third samples. c. Second and third samples. d. First and second samples.

were 30 cases in all the three samples combined where the race designation given by the first group of recorders did not agree with that given by the second group. The amount of information for the three samples combined is 38.

The race of subject's mother was found to be the same, in practically all cases, as that of the father. With respect to religion of father, in the third sample there was complete agreement in 93.4 per cent of the cases with a standard error of 1.11, and in the second sample in 92.6 per cent of the cases with a standard error of 1.17. As not all the three samples were homogeneous, only two and three were combined (symbol c). The percentage of agreement for the combined samples is 93.0 with a standard error of .81. For citizenship of father the percentages of agreement are 95.0, 88.6, and 79.8 in the third, second, and first samples with standard errors of .97, 1.42 and 1.80 respectively. In this item no two samples were homogeneous. Therefore, no comparisons of the samples are shown. The interpretation of all the other entries is identical with that explained above.

A study of the table shows that, by and large, the consistency of the third sample is significantly higher than that of the other two samples which apparently indicates that consistency of recording improved with training. The improvement in consistency is clearly seen from the average percentage of agreement for all the items, excluding those

TABLE V

AVERAGE CONSISTENCY OF ALL ITEMS

	Average percentage of agreement (124 items)	Standard error
First sample	73.2	1.66
Second sample	80.4	1.54
Third sample	85.9	1.16

where the number of cases was less than 500. Thus the average percentage of agreement was 85.9 for the third sample with a standard error of 1.16; 80.4 for the second with a standard error of 1.54; and 73.2 for the first sample with a standard error of 1.66. These differences are statistically significant. The standard errors of the differences of these means are as follows: The difference of the average percentage of agreement between the first and second samples is 3.10 times the standard error of the difference. The comparable difference in terms of standard error for the mean of the second sample compared with that of the third is 2.86. The difference between the first and the third samples is 6.21 times the standard error of the difference.

Another interrelation that is apparent from Table IV is that, in general, items that show a high degree of consistency in one sample tend to show a high degree of consistency in the other samples. This can be determined by means of intra-class correlations. The intra-class coefficient for the three samples is .737, the coefficient being highest for samples two and three where its value is .824 and lowest between samples one and three where its value is .604. The correlation between samples one and two gives a coefficient of .787.

To ascertain the extent of consistency in the work of various units throughout the country, a less elaborate scheme has been used. Each unit, after completing the records of the provisionally released cases, was required to re-record 250 cases. The list of cases to be re-recorded was prepared in Washington and was a random selection from all the cases sent in by that unit. The re-recording was done after all the original schedules had been sent to Washington so that in no instance could there be any opportunity to copy from the earlier recording of the cases. At present some 6,000 duplicate recordings have been sent in from the field. Most of them have been edited and coded and some have been punched and are ready for analysis, similar to that made for the three Federal samples.

It is evident that the errors that we have considered are only in part errors of judgment, since inconsistencies found in the jackets would also tend to increase the margin of error. Thus, if a jacket gives three different statements as to the age of an inmate, an occurrence which is by no means rare, such errors will be reflected in the measure of consistency. Therefore, to some extent, errors can be minimized by more accurate and more complete case history material. While most of the errors noted were made at the stage of recording, undoubtedly a certain percentage has been contributed by the subsequent statistical manipulations in coding and tabulating. These latter errors, however, are negligible except in a few items, such as size of community, to which reference has already been made.

In considering the utility of statistical data for parole prediction there is another phase of reliability that must be taken into account. Consistency, measured in terms that have been mentioned here, may not *per se* indicate a high degree of reliability between the information shown in the jacket and the true facts involved in the case. This shortcoming has been fully recognized and efforts were made to include in the budget of the survey adequate funds to make it possible to undertake certain investigative studies to determine empirically the reliability of the information found in the jackets as compared with the

existing facts. However, this increase in the budget was not allowed, since such inquiries were regarded as impracticable under the circumstances. Despite this limitation, however, the consistency analysis presented herein would seem to indicate that, in all probability, the statistical data with which we are dealing are sufficiently accurate to be of value in determining the practicability of parole prediction from biographic data, which give information concerning the background of the parolee and the circumstances under which his parole was granted and supervised.

THE MEASUREMENT OF PURCHASING POWER

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In emphasizing the fact that a simple reciprocal relationship does not necessarily exist between measures of the price level and of the purchasing power Dr. Wirth F. Ferger has recently[1] rendered a distinct service. His analysis, however, is less definitive than he appears to believe, and the present note offers criticism of the "true" index of purchasing power which he proposes. Is it a suitable measure of the value of money in the hands of the ultimate consumer? This particular problem is not, to be sure, the only one in which the term purchasing power is used (though possibly the only one in which the concept has much significance), but it is clearly a problem to which a "true" index should be appropriate.

Dr. Ferger's purchasing-power index consists of a weighted average of the reciprocals of price relatives, i.e., a weighted average of the purchasing power of the dollar over each of the several commodities.[2] It has considerable formal appeal, since the elements which are averaged—the changes in "individual" purchasing *powers*—bear directly upon the problem at hand. Looked at more closely, the appeal of the index seems to arise from the fact that it fulfills simply and directly two conditions upon which most of our statistical calculations of purchasing power rest: First, that the purchasing power of money varies inversely with each individual price change; and second, that the effect of each price change be proportional to the "importance" of the commodity in the consumer's budget. But the reciprocal of Laspeyre's price formula or of Paasche's,[3] against which Dr. Ferger argues, also fulfills these two conditions though perhaps not so directly. How shall we choose between them? The formal superiority of Ferger's formula furnishes us with a meagre basis for judgment, and to speak of "bias" in this connection is merely to point out that the indexes give differing numerical results. The matter must be decided in terms of the theoretical purpose underlying the two conditions just cited.

I

Basically, the problem of purchasing power is concerned with the effect of price changes upon the satisfaction which the consumer is

[1] "Distinctive Concepts of Price and Purchasing-power Index Numbers," this Journal, Vol. 31 (June, 1936), pp. 258–272.

[2] Taking u_0 and u_1 as the reciprocals of prices in the two indicated periods and v_0 as the amount spent on each item in the base period, Dr. Ferger's index is expressed (*op. cit.*, p. 270) as $S(u_1/u_0)v_0/Sv_0$.

[3] It will be recalled that Laspeyre's formula is Sp_1q_0/Sp_0q_0 and that Paasche's formula is Sp_1q_1/Sp_0q_1.

able to command. The matter has recently been approached explicitly from this point of view by a number of writers,[4] to whom incidentally Dr. Ferger does not refer. In spite of its ingenuity, one may doubt that such analysis is likely to offer much aid in the organization of actual statistical data, except possibly in very trivial cases; but there can be no question as to the desirability of recognizing fully the nature of the theoretical problem in formulating its empirical treatment.[5] With this end in view, we accept the following two propositions as the basis of discussion: First, the point of the purchasing power problem is an evaluation of the change in the consumer's well being—essentially a judgment upon the change in his satisfaction. Second, since statistical data cannot furnish us with an exact basis for such judgment (human satisfaction not being measurable) the empirical treatment of the problem must be in the nature of an approximation.

In this approximative method of dealing with the problem, it must be recognized that the effect of price changes upon the consumer's position is composed of two elements. In the first place, as the cost of the basket of goods originally purchased increases or declines (as compared with the change in money income if this is not constant) the consumer must reduce, or expand, his purchases. In this sense, his "resources" are changed. In the second place, with the shift in the *relative* prices of commodities, the consumer may be able to distribute his spending more effectively, because of substitutions thus made possible. If this second factor were of no importance—either because there were no changes in the relative price structure (all prices rising or falling in the same proportion), or because such changes had no effect on the consumer's behavior—the problem of measuring purchasing power could be satisfactorily solved. For in such a case, a decline, say, in the cost of the original basket of goods would increase the resources of the consumer with constant money income[6] precisely as would a corresponding addition to his money income, and one could say unequivocally that his purchasing power had increased.

[4] For a recent bibliography, see Ragnar Frisch, "Annual survey of general economic theory: theory of index numbers," *Econometrica*, Vol. 4 (January, 1936).

[5] The relation of the problem to the aggregates of satisfaction enjoyed by the consumer in the "base" and in the "given" periods is recognized explicitly only by certain writers, but it colors much of the discussion outside of their particular work. For example, the well known index number "tests," being merely restatements of the fundamental laws of arithmetic and hence applicable only to simple aggregates, imply that on the "goods side" of the problem the several qualitatively distinct commodities can be funded by means of some common denominator, in the present case their utility content. The present writer has discussed the matter somewhat more fully elsewhere. See, "Some basic problems in index number theory," in *Economic Essays in Honor of Wesley C. Mitchell*, New York, 1935.

[6] It is simpler to assume constant money income, although precisely the same argument holds if income varies, provided we observe, not merely whether the original basket increases or declines in cost, but whether the change in cost is algebraically greater or less than that in income, both being in relative form.

Conversely, if the original basket of goods increased in cost, his purchasing power would decline. In a word, Laspeyre's index (rather, its reciprocal) measures the change in the consumer's resources; and if we could ignore changes in the relative price structure, it would furnish us with a proper index of purchasing power.[7]

In general, however, changes in relative costs may have an appreciable effect upon the consumer's position, and these must be taken into account. For example, suppose the total cost of the original basket increases although some goods in the basket cheapen. If the latter goods happen to be ready substitutes for those which rise in price, the consumer may maintain or actually increase his well being, in spite of the decline in his "resources," by shifting his spending from the latter to the former items. Thus, the effect of changes in relative prices, when it exists, introduces an ambiguity into the meaning of the calculation of change in the consumer's resources, and it is precisely at this point that our statistical difficulties enter. When the consumer's resources increase, we may be sure that his satisfaction is increased. For the effect of such substitutions as are made possible by the relative-price changes is to increase his satisfaction still further. But with a decline in resources, we could identify the change in satisfaction—and hence in purchasing power—only if we could compare the loss of well being occasioned by the decline in resources with the gain in well being made possible by substitutions.[8]

The ambiguity resulting from the effect of relative-price changes is especially serious even with increases in the consumer's resources if we compare a series of "given" periods with a single base. Suppose that in one of these "given" periods the consumer's resources have increased by ten per cent and in the next by fifteen per cent. Evidently, his purchasing power is greater in both as compared with the base, but we may not conclude that it is greater in the second "given" period as compared with the first. For the relative-price structure may be much more favorable in the first as compared with the second, thus allowing him to enjoy more satisfaction when his resources have increased by ten per cent than he does when they have increased by fifteen per cent.

[7] The measurement of changes in resources would seem to be the theoretical purpose underlying the two "conditions" cited above as controlling our statistical measurements of purchasing power. Thus, while Dr. Ferger's index seems to fulfill them better from a purely formal standpoint, Laspeyre's formula is the appropriate measure.

[8] It will be recognized that the logic of this proposition is essentially that of Haberler's "upper limit." (G. Haberler, *Der Sinn der Indexzahlen*, pp. 89–90.) A similar analysis based upon Haberler's "lower limit" (*op. cit.*, pp. 90–92) would be equally valid, and would indicate the use of Paasche's formula, instead of Laspeyre's, as a measure of the change in consumer's resources. As a practical matter, however, the quantity data required for Paasche's formula are generally lacking, and for this reason the discussion is concerned solely with the use of Laspeyre's.

It is apparent from the foregoing discussion that Laspeyre's formula[9] tells only part of the purchasing-power story, because the rest is beyond the reach of statistical analysis. A single, accurate measure of purchasing power is out of the question. In spite of this, the conventional fixed-pattern cost-of-living index (Laspeyre's formula) is a useful measure. In the first place, it serves as a good approximation because changes in the consumer's resources probably form a very important part of the price-effect upon the consumer's position, particularly if excessively long-time comparisons are avoided. In the second place, such an index may be used *explicitly* as a first approximation, the interpretation of which is subject to modification in the light of such information as we may have concerning the effect of changes in relative prices. Thus, to take a concrete example, the substantial cheapening of chicken as compared with pork recently observed, together with evidence of actual substitution, should color the conclusions drawn from the cost-of-living index based upon a fixed ratio of consumption of the two. Concerning phenomena like this, our knowledge is all too scanty, but we are certainly not wholly in the dark. The "general characteristics" of the budget items, and such studies as have been and are being made, might, if treated systematically, make possible a very considerable improvement in our treatment of the purchasing power problem. It is by means of such analysis of consumer's purchasing power that we are likely to achieve a more satisfactory solution of the problem than we now have.

How far one can go in taking account of the relative-price component of the problem is not a question that may be answered *a priori*. Furthermore, it is evident that in recognizing this component we have to abandon the neat solution of the problem embodied in a single purchasing-power index, and instead deal with (a) an index which represents only one aspect of the problem, and (b) certain supplementary judgments which, while essentially quantitative in character, are not expressible in explicitly quantitative terms. But this less clear-cut form in which our results must appear simply reflects the quasi-statistical character of the problem, and is thus inevitable.[10]

[9] The formula is of course rather flexible. The base period, for example, may be much broader than any given period, and in some instances even consist of the entire group of given periods. The one logical requirement is that the base prices should apply to the same period as the quantities of the budget.

[10] In this brief discussion, it is impossible to treat in detail a number of points which may legitimately be raised. One, however, should be mentioned. The argument runs in terms of a single consumer and of changes in his satisfaction. May it be carried over to the practical case of consumer *groups* without bringing in unwarranted assumptions concerning the comparability of satisfaction enjoyed by different individuals? It may be stated that the problem of combining consumers arises only with respect to the statistical representativeness of the measure of consumer's resources, and the general representativeness of the supplementary judgments concerning the effect of relative-price changes.

II

The chief advantage which Dr. Ferger claims for his index is that it implies a suitable consumption pattern. Whereas a price index should be based upon a fixed set of quantities, "a purchasing-power-of-money index must be so calculated that the proportional *expenditure* on the various commodities is maintained . . ."[11] Just why this should be, Dr. Ferger does not tell us[12] and it is argued below that the proposition is not true. We shall, however, ignore the question of validity for the moment, and simply inquire whether such a distinction can actually be made between the two measures under consideration.

In what sense does Laspeyre's formula "assume" constant quantities?[13] Evidently if the consumer actually does purchase the same basket of goods in two periods, Laspeyre's formula is subject to a very simple interpretation—namely, as showing the variation in expenditure. But if the formula can be given an important meaning when the consumer does not maintain the same pattern—such as that offered in the first section of this note—it can no longer be considered as assuming, or being dependent on, invariant quantities. Applying the same test to Dr. Ferger's index, it is easy to show[14] that under conditions of proportionate expenditure the index becomes simply the familiar reciprocal of Paasche's formula.

Whatever the merits of this formula,[15] it is yielded by Dr. Ferger's index only if proportionate expenditures are in fact constant. Such an assumption would be bold indeed. While one may possibly find some items in a typical budget of which the quantities purchased remain approximately constant, and others which absorb an approximately constant proportion of the total expenditure, neither is the case for the general run of items.[16] In brief, any method of measuring purchasing power which depends for its meaning on an assumption as to the character of changes in the consumption pattern is not a useful index, whatever the measure may mean under the particular conditions assumed.

[11] *Op. cit.*, p. 271. His italics.

[12] It is true that for a *single commodity*, the price expresses the amount of money exchangeable for a fixed physical unit, and the purchasing power (for this particular commodity) expresses the number of physical units exchangeable for a fixed sum of money, a dollar. Possibly it is this distinction for single commodities which Dr. Ferger had in mind.

[13] From a purely formal standpoint, it is true that only one set of quantities (i.e., q_0) appears in Laspeyre's formula, but this is also true of Dr. Ferger's index. (*Ibid.*, p. 270.) For the only quantities involved appear in the symbol, $v_0 = p_0 q_0$.

[14] Reducing the symbols in his formula (See our footnote 2) to their equivalents in prices and quantities, setting $p_0 q_0 = K p_1 q_1$ for each commodity, substituting and cancelling, the result follows.

[15] See footnote 9, above.

[16] No doubt, the change in expenditure on different items varies greatly, if for no other reason than that commodities are substitutes for one another to widely varying degrees.

In view of the foregoing, it would seem that the issue Dr. Ferger raises as to price and purchasing power indexes—that one should be based on constant quantities and the other on proportionate expenditures—is in reality no issue at all. The distinction is not called for by the problem, and the two indexes discussed (Laspeyre's and his own) do not reflect it in any important sense.

While Dr. Ferger does not, as has been noted, make any serious attempt to show why he considers the distinction is called for, he does give us some hint as to the basis for his belief that it characterizes the two indexes. It will be recalled by those familiar with Dr. Ferger's earlier discussion of the problem of averages[17] that he was primarily concerned in that study with the combination of two or more *similar* rates—say, the speeds of automobiles. In averaging such rates, he quite rightly asserted that the arithmetic or the harmonic mean is indicated according as the terms of the problem "hold constant" the variable appearing in the denominator or the numerator of each of the rates. Now prices may be considered as rates, and if we take the same sort of problem—namely, combining *similar* rates—the point is equally valid. Thus, if the price of bread is different in two periods the proper average will be given by the arithmetic mean if the same number of loaves is bought in each, and by the harmonic mean if the same expenditure is made in each. Similarly, one may carry through the same argument for the prices of different commodities, although the results are trivial, being dependent upon the arbitrary choice of physical units. When, however, Dr. Ferger[18] carries over the argument to the problem of combining relatives—i.e., the rates of rates—he is proceeding upon the flimsiest of analogies.

III

Certain additional points may be raised in connection with Dr. Ferger's discussion. While they do not bear directly upon the main problem, they should be mentioned as possible sources of confusion.

1. His unweighted and weighted indexes are not correlatives—the second does not equal the first if all commodities are equally important. Instead of being an unweighted index of purchasing power relatives, his unweighted index is simply the ratio of the "sums" for two periods, of a dollar's worth of each of the several commodities.

2. While Dr. Ferger sees the absurdity of adding ten loaves of bread and twenty apples in computing his unweighted average, he

[17] "The Nature and Use of the Harmonic Mean," this JOURNAL, Vol. 26 (March, 1931), pp. 36–40.

[18] That this is the basis of his distinction is indicated by his reference to his earlier contribution and his care in showing that his index may be regarded as a weighted harmonic mean of price relatives. *Op. cit.*, pp. 270–271.

gets around the difficulty by expressing all commodities in "homogeneous" units, namely, pounds. (It seems not irrelevant to add that he confines his illustrative material to goods rather than services.) But the "common denominator" implied by the purchasing power problem is human satisfaction, not physical weight—a wage earner who carries home a heavier weekly basket is not better off if the high cost of living is compelling him to purchase coarser and weightier foodstuffs.

3. In setting up his weighted index, Dr. Ferger really gets rid of the problem of arbitrary choice of commercial units by the conventional device of expressing his individual purchasing powers in relative form. But his justification of this procedure is confusing. He develops his weighted index in "aggregative" form,[19] although this appears to be a mere formal manipulation without any real significance.[20] Thus, he is led to make the adjustment for units in the "weights" by which the individual purchasing powers are multiplied. "A perfect corrective factor for the weights is the price (dollars per unit) in the base year p_0, or $1/u_0$. The complete weights are, then, v_0/u_0, which give an accurate measure of the importance of the commodities when their prices (sic) are stated in u's—so many units to the dollar."[21] This seems scarcely an illuminating way in which to put the matter.

REPLY

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I WELCOME the opportunity afforded by Professor Lewis' criticisms to clarify the treatment of certain aspects of the measurement of the purchasing power of money which were treated in my article. With much of his analysis I find myself in substantial agreement. About half of the note concerns a problem which my article did not purport to discuss, however, and should be considered on its own merits.

Dr. Lewis comments that the concept of a purchasing-power index which I developed "has considerable formal appeal," but is less definitive than I appear to believe. If by "formal" he means "theoretical,"

[19] See the left-hand side of his second equation. *Op. cit.*, p. 270.

[20] In the case of certain (simple) price and quantity indexes it is often useful to convert the weighted index of relatives into aggregative form largely because the latter always turns out to be a ratio of money sums. The latter being a definite concept, the aggregative expression may aid in determining the exact meaning of the index in question. But there is no corresponding interpretation of Dr. Ferger s "aggregative," and it is interesting to note that his own subsequent discussion of the index is confined to the average-of-relatives form.

[21] *Op. cit.*, pp. 269–270.

implying that other aspects of any problem to which a purchasing-power index is to be applied require consideration in addition to the strictly logical characteristics of the basic concepts employed, I am in hearty agreement. The title of my article explicitly limited its scope to examining the theoretical aspects of the "distinctive *concepts* of price and purchasing-power index numbers." It may or may not be true that my analysis will "offer [little] aid in the organization of actual statistical data, except possibly in very trivial cases;" but if my contentions concerning the nature of the *concepts* involved are accurate, they should be expected to have some meaningful application to practical problems. Dr. Lewis' opening sentence apparently accepts my central thesis.

Professor Lewis tests the general validity of my analysis by applying it to the measurement of the value of money in the hands of the ultimate consumer. He recognizes that "this particular problem is not, to be sure, the only one in which the term purchasing power is used (though possibly the only one in which the concept has much significance), but it is clearly a problem to which a 'true' index should be appropriate." Perhaps my use of the word "true" was unfortunate: certainly a connotation has been read into the word which was not intended. The word was used merely in contrast with the "pseudo" index of purchasing-power (the reciprocal of a price index) from which my formula was to be distinguished. Certainly after myself criticizing the search for a "universal" or an "ideal" formula, I intended no exclusive or universal implication in the word "true." Still, Professor Lewis is correct in asserting that general principles developed with respect to purchasing-power indexes should be applicable to any problem truly involving the measurement of the value of money. He then tests the principles as applied to the problem of consumers' standards of living, justifying this test by the assertion that the chief advantage which I claim for my index "is that it implies a suitable consumption pattern." I can find no statement in my article which would lend itself to this interpretation.

Most of Professor Lewis' criticism flows from his assertion that "Basically, the problem of purchasing power is concerned with the effect of price changes upon the satisfaction which the consumer is able to command." No analysis is given in support of this point of view, and I regard this as too narrow an approach to the measurement of the purchasing power of money. Money is used for many purposes other than expenditure by consumers; in fact, the volume of transactions represented by the purchase of goods and services by consumers undoubtedly forms a minor part of the total volume of monetary

transactions in this country. I am, therefore, unable to accept the first proposition offered in Section I of the criticism that "the point of the purchasing power problem is an evaluation of the change in the consumer's wellbeing—essentially a judgment upon the change in his satisfaction." In fact, it seems to me that the problem of the wellbeing of the consumer is more concerned with the consideration of budgets and prices, and the possibility of substitution among commodities, than it is with the purchasing power of money as such. Since I do not accept his basic propositions, detailed comment on that part of his analysis based thereon is inappropriate. Dr. Lewis' analysis in the first section of his comments constitutes an interesting attack on an important problem, and one with which I have much sympathy and agreement; it is not, however, a criticism of my study.

Just as unintended connotations were read into my use of the word "true," may I also disclaim the interpretation placed on my use of the word "bias." Dr. Lewis states, " . . . to speak of 'bias' in this connection is merely to point out that the indexes give differing numerical results." I myself made this same objection to the judgment of a formula on the basis of its simple comparison with some other one (p. 266). When I used the word (at the bottom of p. 267), the context was intended to give it quite a different connotation. My statement was that "Equal original weights of one unit each do not actually result in an equally weighted index number system, but one biased in the direction of the price changes [these being of equal percentage amount but of opposite direction] of the commodity or commodities which have become relatively more expensive." This referred to a *demonstrated* preponderance of effect of one price change purportedly equal to another, and pointed out the *source* of the numerical difference in results, rather than merely indicating its existence.

In the second section of his notes, Professor Lewis directs certain criticisms against specific points of my analysis which merit comment. After noting that I maintain that "a purchasing-power-of-money index must be so calculated that the proportional *expenditure* on the various commodities is maintained, rather than assuming constant quantities purchased," he comments, "Just why this should be, Dr. Ferger does not tell us . . . " At another place, he claims that I do not "make any serious attempt to show why [I consider] the distinction is called for." In defense, I point out that at two places I do discuss the relationship between my treatment and the economic theory relating to the nature and functions of money and prices. In Section III of my article, dealing with the concept of purchasing power, I state, "Prices, being money ratios, have several aspects, corresponding to the different functions

performed by money." (p. 263.) Likewise, the final section of my paper (Section V) consists of an attempt briefly to suggest the application to economic theory of the differentiation I had analyzed in detail. Criticisms should not completely ignore relevant sections of the analysis toward which they are directed.

Lewis goes on to say that my reference to my previous article apparently gives a hint as to my reason for preferring, for the index of the value of money, a formula which is equivalent to the reciprocal of the weighted harmonic mean of prices in their usual form. After a short discussion, recognizing the different assumptions implicit in averaging rates by the use of the arithmetic and harmonic means, Professor Lewis dismisses this whole reasoning by asserting that when one carries over the argument "to the problem of combining relatives—i.e., the rates of rates—he is proceeding upon the flimsiest of analogies." This objection has been discussed by others, and a reply suggested by Geo. R. Davis in the 1932 "Proceedings Supplement" of this JOURNAL (pp. 60–61). The derivation of my formula was, however, based on no such "analogy," and did not in fact involve the use of the harmonic mean. It was only after developing the formula in aggregative form that its identity with the reciprocal of the harmonic mean of relatives was pointed out: "a second method of viewing the whole matter of formula and weights." The validity of this formula thus rests on no "analogy."

It should be pointed out, however, that all average-of-relatives price index numbers rest on just as "flimsy" a basis. What are the implicit assumptions of the ordinary *arithmetic* average-of-relatives price formula? Does it really show the varying price of a constant bill of goods? I have been unable to accept the strictures against carrying the principles of the averaging of rates over into the problems of averaging rates of rates. A complaint against the use of the harmonic mean in this case, however, applies equally against the arithmetic mean, unless we are to fall into the error of accepting the commonplace without question, while objecting to the novel.

At another place, after noting the tacit assumption of the harmonic formula of constant proportional expenditures, Dr. Lewis points out that "In brief, any method of measuring purchasing power which depends for its meaning on an assumption as to the character of changes in the consumption pattern is not a useful index, whatever the measure may mean under the particular conditions assumed." Let me point out again that *some* assumption is always implicit in every formula based on a single set of weights, concerning the character of the changes (or lack of change) in quantities accompanying the observed

price movements. The arithmetic mean of relatives with constant weights assumes *unchanging amounts* just as truly as the harmonic assumes unchanged proportional *expenditures*. Professor Lewis believes an assumption of constant proportionate expenditures "would be bold indeed." It is my conviction that an assumption of constant quantities purchased, as prices vary, is many times bolder, as applied to the general run of commodities and services. This latter assumption challenges, in fact, the basic function of the price system as a regulator of consumption. It assumes that prices mean nothing when consumers go into the market to make their purchases. It seems to me to require little analysis to show that a constant-expenditure demand curve comes closer to reality for consumers' goods than does a vertical or completely inelastic demand curve, which is the assumption implied by the arithmetic average.

This is all beside the point, however, since my discussion related, not to the "consumption standard," but to the conceptual meaning of an index of the purchasing power of money. The analysis made no assumption whatever as to the way money is actually spent by consumers or anyone else. My point was simply that if we are trying to measure changes in the quantities of goods a given amount of money will buy over periods of changing prices, we must measure just this, keeping invariant other factors such as changing consumer habits. The money must be spent on the various commodities in constant proportions, and measurements made of the changes in the average quantities received for this money.

I come now to the last three specific comments of Professor Lewis. He points out that the "unweighted and weighted indexes are not correlatives—the second does not equal the first if all commodities are equally important." This appears to be a valid "formal" criticism of these formulas, which I had not noticed. I do not know whether or not this indicates some fallacy in one or the other. The unweighted index has, of course, no practical value since it could be applied only to articles expressed in homogeneous units—and I fully realize that no physical units are truly homogeneous as between different commodities. A pound of coal is not comparable with a pound of butter, as was noted in my paper. I developed this unweighted formula only as an expository tool, and gave no further attention to it after passing to the problem of the weighted index. There may be some simple algebraic explanation for the non-correlative nature of these two formulas, which has escaped me so far.

The second of the final criticisms concerns the unweighted index and loses its force when this index is considered merely as an expository

device. It is noted that I confined my illustrations to goods rather than including services. In the weighted index, however, it is obvious that the prices of services could easily be accommodated, man-hours of service being included along with the diverse commodity units of pounds, quarts, and yards. The statement, "But the 'common denominator' implied by the purchasing power problem is human satisfaction, not physical weight . . . " has already been challenged.

The final criticism is that my procedure of first developing the weighted index in aggregative form before expressing it as an average-of-relatives "is confusing." I am not the one to judge the accuracy of the charge of unskillful presentation. An exposition by means of concrete numerical examples is not as elegant as one couched in terms of algebraic symbols and mathematical transformations, and based on quoted theorems. I preferred, however, to attempt to make the explanation intelligible to non-mathmatical readers by first developing simple numerical illustrations, as well as hoping that the analysis would carry more conviction through a more thorough understanding than would ordinarily be assimilated from an elegant mathematical derivation.

The last few lines of the criticism appear again to suggest uncritical acceptance of the commonplace and repugnance to the unfamiliar. By inserting the word "sic" in a quotation from my study, Dr. Lewis apparently regards as an error my reference to "so many units to the dollar" as representing true *prices*. As I tried to point out in my earlier article,[1] prices, being ratios between units of commodities and units of a standard, can be expressed in either one of two forms, neither one of which can be regarded as any more arbitrary than the other. There are places where some prices are commonly quoted in terms of quantities obtainable for a unit of money. In India, for instance, the price of flour may be "7 sehrs to the Rupee" and at a later time may *rise* to "6 sehrs to the Rupee." If our prices were customarily expressed in this form and our price index formulas had developed with the use of the familiar arithmetic mean of relatives, the result would be exactly that yielded by the harmonic mean of prices as we do actually quote them. Unless this basic idea is grasped, and either accepted or refuted, further discussion is futile.

[1] "The Nature and Use of the Harmonic Mean," this JOURNAL, Vol. 26 (March, 1931), pp. 36–40.

THE CONCEPT OF CONFIDENCE OR FIDUCIAL LIMITS APPLIED TO THE POISSON FREQUENCY DISTRIBUTION*

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The idea of the fiducial interval, introduced by R. A. Fisher,[1] has provided the key to the solution of some statistical problems of a type which formerly resisted analysis. As developed by J. Neyman,[2] it has resulted in the definition of the concept of "confidence belts" corresponding to different "confidence coefficients," for various frequency distributions. Clopper and Pearson[3] make use of these concepts to calculate, for certain specified degrees of confidence, the limits of estimates of the composition of a population which follows the binomial frequency distribution, when each such estimate is calculated from the composition of a single small sample: A sample of n units drawn from a large population contains x units having a certain character A; p is the proportion of A-units in the population. If x/n is used as an estimate of the value of p, the limits between which p is likely to lie, for two different degrees of confidence, are shown in figures 4 and 5 of their paper.

The application of the same method to the caluclation of similar limits for the Poisson frequency distribution appears to offer no obstacles, and the limits so obtained form a valuable supplement to those for the binomial.

METHOD OF CALCULATION

A large population has a *small* fraction p of its units bearing character A. A fairly large sample of n units is taken at random and the number x of A-units in it is enumerated. The chance of occurrence of different values of x will be given more and more accurately by the terms of the Poisson distribution:

$$e^{-m}\left(1 + m + \frac{m^2}{2!} + \frac{m^3}{3!} + \cdots\right) \qquad (1)$$

$(m = np)$, as $p \to 0$ and $n \to \infty$.

* This subject has been treated by F. Garwood under the title "Fiducial Limits for the Poisson Distribution" in *Biometrika* 28 (1936) 437–442, which came to the attention of the Editor after this article was accepted for publication. Dr. Ricker's presentation appeared to be sufficiently different to warrant the publication of this article according to the original decision.—*Ed.*

[1] Fisher, R. A. "Inverse probability." *Proc. Camb. Phil. Soc.* 26 (1930), 528.

[2] Neyman, J. Note I to paper "On the two different aspects of the representative method." *Journ. Roy. Stat. Soc.* 97 (1934), 589–593.

[3] Clopper, C. J., and E. S. Pearson. "The use of confidence or fiducial limits applied to the case of the binomial." *Biometrika* 26 (1934), 404–413.

For a given value of m, find now the term x_1 in this frequency distribution such that the sum of the terms from x_1 to infinity is equal to or less than 0.025, while the sum from (x_1-1) to infinity is greater than 0.025; or briefly:

$$\Sigma(m; x_1 \cdots \infty) \leqq 0.025 < \Sigma(m; \overline{x_1 - 1} \cdots \infty). \qquad (2)$$

Similarly find the term x_2 such that the sum of all terms from 0 to x_2 is equal to or less than 0.025, while the sum from 0 to (x_2+1) is greater than 0.025; or briefly:

$$\Sigma(m; 0 \cdots x_2) \leqq 0.025 < \Sigma(m; 0 \cdots \overline{x_2 + 1}). \qquad (3)$$

If such points x_1 and x_2 be determined for all values of m from 0 upwards, and they be plotted as in the accompanying figure, a pair

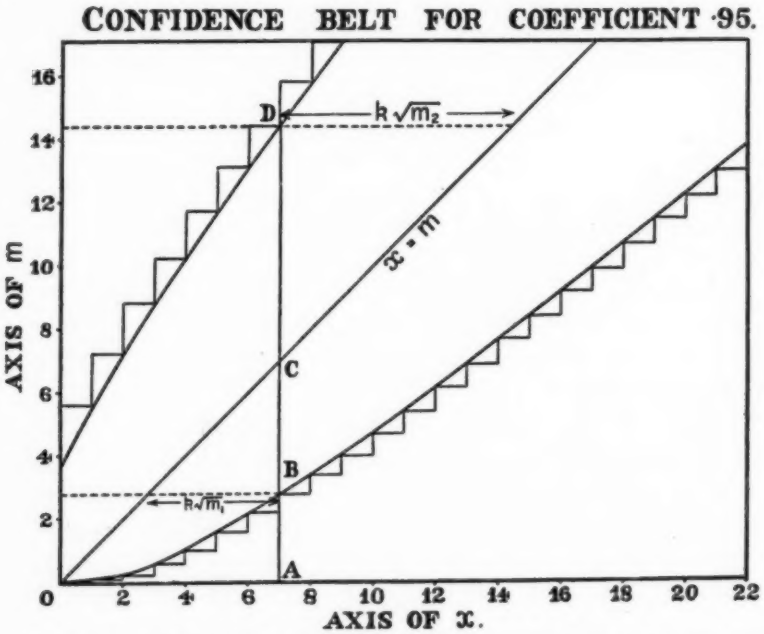

Diagram illustrating confidence limits for Poisson distributions, and Professor Pearson's approximation thereto calculated from the normal distribution. It should be noted that the approximation need be used only when x is greater than 50 (the limit of the accompanying table) and would be of little value with $x = OA = 7$, as shown here for purposes of illustration.

of stepped lines is obtained, the steps occurring because of the fact that x_1 and x_2 values must be integral. Points on these lines satisfy conditions (2) and (3) above; it follows therefore that in the long run of statistical experience, from whatever populations following a Poisson distribution samples are drawn, we may expect at least 95 per cent of points (x, m) will lie inside the boundaries of the stepped belt, and

not more than 5 per cent on or outside the boundary. If curves be drawn as in the figure joining the inside corner points of the boundaries, they will serve equally as well as the stepped lines (since x values are always integral) to obtain *confidence* or *fiducial limits* for m, associated with a confidence coefficient of 0.95. In the same way, confidence limits may be calculated and plotted, corresponding to other confidence coefficients.

Limits of confidence so calculated may be applied to any unique random sample which a priori knowledge or accumulated experience demonstrates to be a member of a series having a Poisson frequency distribution. Failing these, internal evidence of such membership may be consulted: i.e. since the Poisson form obtains when p is small, if in a sample x/n (which is an estimate of p) be small, then the distribution to which it belongs may safely be considered Poisson. *How* small x/n must be in such a case is partly a matter of taste; the writer considers values up to 0.01 above suspicion, while values as large as 0.05 may be accepted, with greater circumspection. Another rule, having about the same import, is to use these Poisson limits when the limits given on Clopper and Pearson's binomial charts become difficult to read, by reason of the small size of x/n.

In calculating fiducial limits as above, use was made of H. E. Soper's table[4] of the general term of Poisson's exponential expansion, and of Lucy Whitaker's table[5] of the same. The first-mentioned proceeds from $m=0.1$ to $m=15.0$ by tenths, the second from $m=1$ to $m=30$ by units. In Soper's table, probabilities corresponding to successive x-values were added at each end of the series, until the sum amounted to 0.005 or 0.025, corresponding to confidence coefficients of 0.99 and 0.95 respectively. In general, the terms would not add to exactly these quantities, but it was possible to choose the m-value which came closest to doing so, and interpolation would give this limiting value to the nearest hundredth. Whitaker's table was more convenient in that the addition was already performed, but the coarser grouping of m-values made it necessary to interpolate to get the limiting value to the nearest tenth. This could be done in the table itself, or more conveniently by interpolating between limiting values, choosing a few which were accurately known, as base points. The one method was used to check the other. Neither table however covered the whole range necessary to take the fiducial table up to $x=50$, so calculations of the necessary parts of the Poisson series were made for m-values up to $m=71$, limits found by addition as before, and the table filled in by extensive

[4] *Biometrika* 10 (1918), 25.

[5] *Biometrika* 10 (1918), 36. Both tables are reprinted in *Tables for Statisticians and Biometricians*, 2nd Edition, Part 1. Cambridge University Press.

$$\frac{x-m_1}{\sqrt{m_1}} = k$$

interpolation. It is believed that this method has provided a table having the first decimal place accurate or nearly so.[6]

The table proceeds only to $x=50$, this being a somewhat arbitrary limit, dictated by the time available for its calculation. But since the rule must by definition apply to the whole of statistical experience, any such limitation of x-values is theoretically unsound. Professor E. S. Pearson of University College, London, who pointed this out to the writer, at the same time suggested a rough method of extrapolating the table, which is as follows: "As m increases the Poisson distribution can be more and more closely represented by a normal curve. Thus in the notation used above we shall have approximately

$$\Sigma(m; x_1 \cdots \infty) = \int_k^\infty \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt \tag{4}$$

$$\Sigma(m; 0 \cdots x_2) = \int_{-\infty}^k \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt \tag{5}$$

where k is the ratio of the deviation from the mean to the desired point, over the standard deviation. Thus in the first integral $k=(x_1-m_1)/\sqrt{m_1}$, and for the second $k=(m_2-x_2)/\sqrt{m_2}$. To make the expressions in (4) and (5) equal 0.025 we should take $k=1.9600$, and to make them equal 0.005 take $k=2.5758$.

"The diagram shows the confidence belt with the coefficient 0.95. For an observed value $x=OA=AC$ we have $m_1=AB$, $m_2=AD$. Further, $BC=x-m_1=k\sqrt{m_1}$; $DC=m_2-x=k\sqrt{m_2}$.

Or,
$$\begin{cases} m_1^2 - m_1(2x + k^2) + x^2 = 0 \\ m_2^2 - m_2(2x + k^2) + x^2 = 0 \end{cases}$$

so that
$$\begin{cases} m_1 = x + k^2/2 - k\sqrt{k^2/4 + x} \\ m_2 = x + k^2/2 + k\sqrt{k^2/4 + x} \end{cases}$$

Using the values of k given above, we find that for confidence coefficient 0.95,

$$(m_2, m_1) = x + 1.92 \pm 1.960\sqrt{x + 1.0} \tag{6}$$

and for confidence coefficient 0.99,

[6] A paper in *Biometrika* 27 (1935), 273–292, by J. Przyborowski and H. Wileński, entitled "Statistical principles for routine work in testing clover seed for dodder," contains the upper fiducial limits for confidence coefficient 0.99 ($\alpha=0.995$ in their notation). They are however calculated quite differently, and more accurately, from the table of the Incomplete Gamma Function. The agreement of our values with theirs is not exact, but shows only minor differences: usually 0.1 greater, in one case 0.2. The authors quoted give no *lower* limits.

$$(m_2, m_1) = x + 3.32 \pm 2.576\sqrt{x + 1.7}. \qquad (7)''$$

Example: At $x = 50$, how do confidence limits so calculated compare with those in the table?

Confidence coefficient	0.95		0.99	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
From equations (6) and (7)	37.9	65.9	34.8	71.8
From the table	37.0	65.9	33.6	71.3
Old method	36.1	63.9	31.8	68.2

It is evident that even at $x = 50$ this method gives confidence limits of sufficient accuracy for ordinary purposes, and better approximation can be expected as x increases.

It should be noticed that a different method of dealing with this problem has been in use for some time. When in a sample x was found to be fairly large, it was considered as an estimate of the mean, hence also of the variance, of the Poisson distribution to which it belonged. Limits of probability corresponding to our 0.95 confidence coefficient were then calculated from the formula

$$(m_2, m_1) = x \pm 1.960\sqrt{x}$$

which is tantamount to assuming $BC = CD = k\sqrt{x}$ in the figure. Limits so calculated have been entered at the foot of the schedule above. It is evident that taken as a whole they are a much poorer estimate of the true limits of confidence than are those calculated by Professor Pearson's method.

EXAMPLES OF USEFULNESS

The accompanying table may be used in all cases where the Poisson distribution is appropriate—i.e., in cases where p (the fraction of "successes") is small. In a few cases either the Poisson limits or the binomial limits of Clopper and Pearson may be successfully used; the limits in such cases occupy the lower left corner of their charts.

Example 1. A sample of 100 ($=n$) taken from a large run of migrant sockeye salmon contains 5 ($=x$) which are two years old, the remainder being yearlings. The best estimate of the proportion p of two-year-olds in the total run is $5/100 = 0.05$. Between what limits may we be confident the value of p lies?

Adopting the 0.99 confidence coefficient, and referring to the table, we may be almost certain that the proportion of second year fish is not less than $1.0/100 = 0.010$, and not greater than $14.1/100 = 0.141$. Reference to the binomial chart gives limits of 0.02 and 0.13, as nearly as they can be read.

FIDUCIAL OR CONFIDENCE LIMITS FOR POISSON FREQUENCY DISTRIBUTIONS

x	Confidence coefficient				x	Confidence coefficient			
	0.99		0.95			0.99		0.95	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit		Lower Limit	Upper Limit	Lower Limit	Upper Limit
0	0.0	5.3	0.0	3.7					
1	0.0	7.4	0.1	5.6	26	14.7	42.2	17.0	38.0
2	0.1	9.3	0.2	7.2	27	15.4	43.5	17.8	39.2
3	0.3	11.0	0.6	8.8	28	16.2	44.8	18.6	40.4
4	0.6	12.6	1.0	10.2	29	17.0	46.0	19.4	41.6
5	1.0	14.1	1.6	11.7	30	17.7	47.2	20.2	42.8
6	1.5	15.6	2.2	13.1	31	18.5	48.4	21.0	44.0
7	2.0	17.1	2.8	14.4	32	19.3	49.6	21.8	45.1
8	2.5	18.5	3.4	15.8	33	20.0	50.8	22.7	46.3
9	3.1	20.0	4.0	17.1	34	20.8	52.1	23.5	47.5
10	3.7	21.3	4.7	18.4	35	21.6	53.3	24.3	48.7
11	4.3	22.6	5.4	19.7	36	22.4	54.5	25.1	49.8
12	4.9	24.0	6.2	21.0	37	23.2	55.7	26.0	51.0
13	5.5	25.4	6.9	22.3	38	24.0	56.9	26.8	52.2
14	6.2	26.7	7.7	23.5	39	24.8	58.1	27.7	53.3
15	6.8	28.1	8.4	24.8	40	25.6	59.3	28.6	54.5
16	7.5	29.4	9.2	26.0	41	26.4	60.5	29.4	55.6
17	8.2	30.7	9.9	27.2	42	27.2	61.7	30.3	56.8
18	8.9	32.0	10.7	28.4	43	28.0	62.9	31.1	57.9
19	9.6	33.3	11.5	29.6	44	28.8	64.1	32.0	59.0
20	10.3	34.6	12.2	30.8	45	29.6	65.3	32.8	60.2
21	11.0	35.9	13.0	32.0	46	30.4	66.5	33.6	61.3
22	11.8	37.2	13.8	33.2	47	31.2	67.7	34.5	62.5
23	12.5	38.4	14.6	34.4	48	32.0	68.9	35.3	63.6
24	13.2	39.7	15.4	35.6	49	32.8	70.1	36.1	64.8
25	14.0	41.0	16.2	36.8	50	33.6	71.3	37.0	65.9

Foerster[7] has already made use of the Poisson limits in cases like the above.

Fiducial limits for the Poisson distribution may also be used in cases of a type where those for the binomial are not applicable. In such cases p and x are known, but not m $(=np)$. We wish to know the limits of confidence which attach to x when it is used as an estimate of m, or more rarely to x/p as an estimate of n. This situation arises whenever the density of particles suspended in a fluid is estimated by counting the number taken in a small known volumetric fraction of it. The writer has already published[8] an example of this taken from the

[7] Foerster, R. E. "An investigation of the life history and propagation of the sockeye salmon (*Oncorhynchus nerka*) at Cultus Lake, British Columbia." No. 5. *Journ. Biol. Board Can.* 2 (3) (1936), 311–333.

[8] Ricker, W. E. "Statistical treatment of sampling processes useful in the enumeration of plankton

field of plankton enumeration—the field in which it was originally developed. The hypothetical illustration to follow pertains to quite a different situation, but the treatment is identical.

Example 2. In the course of studies of hay-fever infections, counts were made of the quantity of pollen in the atmosphere. In one test, pollen was filtered from 1 cc. of air, and the number of grains present counted as 45. The density of pollen in the atmosphere near this point may be estimated as 45 grains per cc. What confidence may be placed in this estimate?

Obviously the applicability of Poisson fiducial limits in such a case hinges upon a demonstration that the numbers of pollen grains in successive samples constitute a Poisson frequency distribution. This may be done most easily by thinking of the volume of air under consideration as containing a large number N of cubic centimeters, throughout which pollen grains are randomly mixed; the total number n of pollen grains in this volume is great, but not so great that crowding or cohesion might make their distribution other than random. For each individual grain, the chance of occurring in the 1 cc. sample is $1/N$; the chance of its being missed is $(1-1/N)$. The distribution of numbers of pollen grains in a great number of 1 cc. samples (the earlier samples being replaced in turn) is of the binomial form: $\{(1-1/N)+1/N\}^n$. We know $1/N$ is small; call it p. Putting $m=np$, this binomial distribution may therefore conveniently be represented by the Poisson distribution. Hence, when only a single sample is at hand, the reliability of the number of grains x in it as an estimate of the number of grains *m per cc.* in the whole volume may be found from the table of fiducial limits for Poisson distributions.

It may be well to repeat the conditions upon which this demonstration is based; which are (1) that the units being enumerated are randomly distributed throughout the medium, and (2) that the volume (or area, etc.) of the medium taken in the sample be small in relation to the volume not so taken.

Return now to the example. The number of grains counted, x, is 45. Adopting the 0.95 confidence coefficient and referring to the table, the probable limits of m are 32.8 and 60.2. We may therefore say at once that the abundance of pollen in the region sampled is probably between 33 and 60 grains per cubic centimeter.

Example 3. A sample dredged from 500 square centimeters of the bottom ooze in the deep water of a certain lake contains 80 organisms

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organisms." *Archiv. f. Hydrobiol.* 31 (1937), 68–84. It may be noticed that in this paper the formulae corresponding to (6) and (7) above were calculated somewhat differently, but give nearly the same results.

of a certain species. Previous experience on such lakes has shown that such organisms are likely to be randomly distributed over the ooze surface. What were the probable limits of abundance of the organism in question when the sample was taken?

Adopting the 0.95 confidence coefficient, and putting $x=80$ in formula (6) above, we obtain

$$m_1=64.3, \qquad m_2=99.6$$

The density of the organisms probably lies between 64 and 100 per 500 square centimeters, or between 1280 and 2000 per square meter.

ACKNOWLEDGMENT

The writer has received greatest assistance in the preparation of the fiducial table from Mr. J. W. Hopkins, of the National Research Council, Ottawa, Canada. Professor E. S. Pearson of University College, London, read the manuscript and made valuable suggestions, as well as offering the independent contribution noted in the text.

NOTES

ON THE ELIMINATION OF VARIABLES IN MULTIPLE CORRELATION

IN HIS recent paper which appeared in this JOURNAL, Waugh treated the problem of eliminating variables by means of adjoint determinants. In the following pages, we shall show that the same problem may be treated in an elementary manner by using only the four operations—addition, subtraction, multiplication, and division.

I. THEORY

For simplicity, let us consider a problem of four variables. *Let r_{ij} be the simple correlation coefficients, and let s_{ij} satisfy the following 4^2 equations:*

$$\sum_{j=1}^{4} r_{ij}s_{jk} = \begin{cases} 1 & (i=k) \\ 0 & (i \neq k) \end{cases} \qquad (i, k = 1, 2, 3, 4). \tag{1}$$

Then the multiple regression equations are

$$\begin{aligned} s_{11}z_1 + s_{12}z_2 + s_{13}z_3 + s_{14}z_4 &= 0, \\ s_{21}z_1 + s_{22}z_2 + s_{23}z_3 + s_{24}z_4 &= 0, \\ s_{31}z_1 + s_{32}z_2 + s_{33}z_3 + s_{34}z_4 &= 0, \\ s_{41}z_1 + s_{42}z_2 + s_{43}z_3 + s_{44}z_4 &= 0, \end{aligned} \tag{2}$$

where $z_i = x_i/\sigma_i$, x_i being measured from its mean.

If we divide the first, second, third, and fourth equations by $-s_{11}$, $-s_{22}$, $-s_{33}$, $-s_{44}$, we obtain the usual multiple regression equations expressed in terms of β_{ij}.

Without losing any generality, let us suppose z_1 is to be eliminated. Multiplying the first equation of (2) by $-1/s_{11}$, we secure

$$-z_1 + \beta_{12}z_2 + \beta_{13}z_3 + \beta_{14}z_4 = 0. \tag{3}$$

Now multiplying equation (3) by s_{21}, s_{31}, s_{41} and adding to the second, third, and fourth equations in (2) respectively, we obtain

$$\begin{aligned} (s_{22} + s_{21}\beta_{12})z_2 + (s_{23} + s_{21}\beta_{13})z_3 + (s_{24} + s_{21}\beta_{14})z_4 &= 0, \\ (s_{32} + s_{31}\beta_{12})z_2 + (s_{33} + s_{31}\beta_{13})z_3 + (s_{34} + s_{31}\beta_{14})z_4 &= 0, \\ (s_{42} + s_{41}\beta_{12})z_2 + (s_{43} + s_{41}\beta_{13})z_3 + (s_{44} + s_{41}\beta_{14})z_4 &= 0, \end{aligned} \tag{4}$$

which are the required multiple regression equations when z_1 is eliminated.

II. PRACTICAL PROCESS

In practical computation, we are interested only in the coefficients of the variables. Thus, we may put down the coefficients s_{ij} of z_j in equations (2) as follows:

(5)

	1	2	3	4
1	s_{11}	s_{12}	s_{13}	s_{14}
2		s_{22}	s_{23}	s_{24}
3			s_{33}	s_{34}
4				s_{44}

Multiplying the first row by $-1/s_{11}$, we obtain the first row in (6):

$$-1,\ \beta_{12},\ \beta_{13},\ \beta_{14}\ .$$

If we multiply these numbers by s_{21}, s_{31}, s_{41} and add to the second, third, and fourth rows respectively, we obtain

(6)

	1	2	3	4
1	-1	β_{12}	β_{13}	β_{14}
2	0	$(s_{22}+s_{21}\beta_{12})$	$(s_{23}+s_{21}\beta_{13})$	$(s_{24}+s_{21}\beta_{14})$
3	0		$(s_{33}+s_{31}\beta_{13})$	$(s_{34}+s_{31}\beta_{14})$
4	0			$(s_{44}+s_{41}\beta_{14})$

The numbers in the last three rows and three columns are symmetric, and hence the numbers below the principal diagonal may be omitted.

If we wish to eliminate z_3, and also wish to determine the regression equations of z_1 on (z_2, z_4), and of z_2 on (z_1, z_4), we then rearrange the table of numbers (5) as follows:

(7)

	3	1	2	4
3	s_{33}	s_{31}	s_{32}	s_{34}
1		s_{11}	s_{12}	s_{14}
2			s_{22}	s_{24}
4				s_{44}

The last row of numbers may be omitted since we are not interested in the regression equation of z_4 on (z_1, z_2). We now apply the method for computing the numbers in Table (6).

This method is theoretically the well known Gauss method of elimination. A mechanical process of carrying out Gauss' method has been given by Doolittle. The latter method gives a check sum to ascertain

our computation in each step. The method is so very familiar to many students in social sciences that it is almost trifling to illustrate it.

III. NUMERICAL EXAMPLE

Let the simple correlation coefficients be

(8)

	1	2	3	4
1	1	.25	.64	.40
2		1	.32	− .50
3			1	.16
4				1

Then the set of s_{ij} satisfying equations (1) is as follows:

(9)

	1	2	3	4
1	2.371574	−0.864536	−1.047016	−1.213375
2		2.022237	−0.319091	1.407987
3			1.776188	−0.024929
4				2.193332

We wish to eliminate the variable z_3. The computation process is given below.

TABLE 10

	−R	3	1	2	4	Sums	Check
3a	−.56300351	1.7761879	−1.0470160	−0.3190906	−0.0249290		.3851523
3b		−1	.5894737	.1796491	.0140351	−.2168421	−.2168421
1a			2.3715743	−0.8645361	−1.2133752		−.7533529
1b			−.6171884	−0.1880955	−0.0146950		.2270372
1c			*1.7543860*	*−1.0526316*	*−1.2280702*	−.5263158	−.5263158
1d	−.57		−1	.60	.70	.30	.30
2a				2.0222366	1.4079872		3.2465972
2b				−.0573243	−.0044785		.0691923
2c			*−1.0526316*	*1.9649123*	*1.4035088*	2.3157895	2.3157895
2d	−.50892857		.5357143	−1	.7142857	.25	.25
4a					2.1933323		2.3630154
4b					−.0003499		0.0054056
4c			*−1.2280702*	*1.4035088*	*2.1929825*	2.3684211	2.3684210
4d	−.456		.56	.64	−1	.20	.20

In Table (10), the underlined numbers are the coefficients s'_{ij} of z_1, z_2, z_4 when the variables z_3 has been eliminated. Expressing the multiple regression equations in terms of β's, we have

$$z_1 = .60z_2 \quad +.70z_4,$$
$$z_2 = .53571z_1 + .71429z_4,$$
$$z_4 = .56z_1 \quad +.64z_2.$$

If we are not interested in the last equation, the computation in lines 4a, 4b, 4c, 4d may be omitted.

Observe that this method may be applied to obtain the standard error function of a regression equation. For a description of this method (without mathematical demonstration), the reader is referred to the author's forthcoming paper entitled "Two Methods for Determining the Most Probable Values and Certain Related Constants."[1]

IV. THE ELIMINATION OF SEVERAL VARIABLES

Suppose we have a problem of seven variables, and the numbers s_{ij} are computed in the order (1, 2, 3, 4, 5, 6, 7). Suppose that we wish to eliminate the variable x_4 first, then x_2 and x_5, and we are interested in the regression equations of x_6 on (x_1, x_3, x_7) and x_7 on (x_1, x_3, x_6). Then we should rearrange the numbers s_{ij} in the order (4, 2, 5, 6, 7, . . .) or (4, 2, 5, 7, 6, . . .), the order of the last two numbers (1, 3) being immaterial. We now apply the elimination method to eliminate x_4, x_2, x_5.

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NOTE ON PROFESSOR KELLEY'S METHOD

IN REVIEWING Professor Kelley's *Essential Traits of Mental Life* in the September issue of this JOURNAL I made the statement that original units were necessary to obviate what I called a trivial solution. I now propose to compare the two solutions, amplifying my comment in the sixth paragraph of the review.

If the original variables are standardized and unit variances are introduced in the diagonals of the matrix of covariances, the latter reduce to correlations. Professor Kelley's method can indeed be applied to such a matrix, but the solution will be inconsistent with that obtained by employing variances and covariances and subsequently standardizing all the variables, unless all original variances are equal. I shall illustrate these points by a two-variable example.

[1] To be published in the *Journal of Social Sciences*, the Institute of Social Sciences, Academia Sinica, Nanking, China.

Let the original tests be x_1 and x_2 with $\sigma^2_{x_1}=9$, $\sigma^2_{x_2}=4$, and $p_{12}=3$, $r_{12}=.5$. Then $\tan 2\theta=2p_{12}/(v_1-v_2)$; $\theta=25°6'$; $\cos\theta=.906$; and $\sin\theta=.424$. If the factors be denoted by y_1 and y_2 the orthogonal transformation becomes

$$\begin{aligned} y_1&=.906x_1+.424x_2 \\ y_2&=-.424x_1+.906x_2 \end{aligned} \tag{1}$$

From these equations we may next calculate the following constants: $\sigma^2_{y_1}=10.411$, $\sigma^2_{y_2}=2.596$, $\sigma_{y_1}=3.227$, $\sigma_{y_2}=1.611$.

In order to standardize we shall next use the following standard scores:

$$z_1=x_1/\sigma_{x_1}=\tfrac{1}{3}x_1,\ z_2=x_2/\sigma_{x_2}=\tfrac{1}{2}x_2 \tag{2}$$

$$w_1=y_1/\sigma_{y_1}=y_1/3.227,\ w_2=y_2/\sigma_{y_2}=y_2/1.611 \tag{3}$$

Substituting (2) and (3) in equations (1),

$$\begin{aligned} w_1&=.842z_1+.263z_2 \\ w_2&=-.790z_1+1.125z_2 \end{aligned} \tag{4}$$

It will be observed that $\sum w_1w_2=.000$, hence the standardized variables are uncorrelated. This transformation, however, is no longer orthogonal, as noted in the review.

We may also obtain a factor pattern from equations (4) to produce the correlation as a check:

$$\begin{aligned} z_1&=.974w_1-.228w_2 \\ z_2&=.684w_1+.729w_2 \qquad \sum z_1z_2=.500 \end{aligned} \tag{5}$$

Let us next standardize the original variables at the outset, denoting the tests as z_1 and z_2. Since $v_1=v_2$, $\theta=45°$ and $\cos\theta=\sin\theta=1/\sqrt{2}$. The factors may then be written

$$\begin{aligned} y_1&=(z_1+z_2)/\sqrt{2} \\ y_2&=(-z_1+z_2)/\sqrt{2} \end{aligned} \tag{6}$$

We again calculate the constants, $\sigma^2_{y_1}=\frac{3}{2}$, $\sigma^2_{y_2}=\frac{1}{2}$, $\sigma_{y_1}=\sqrt{\frac{3}{2}}$, $\sigma_{y_2}=\sqrt{\frac{1}{2}}$ in order to standardize the factors y_1 and y_2. Thus

$$w_1=y_1/\sigma_{y_1}=y_1/\sqrt{\tfrac{3}{2}},\ w_2=y_2/\sigma_{y_2}=y_2/\sqrt{\tfrac{1}{2}}. \tag{7}$$

Substituting (7) in (6) we find

$$\begin{aligned} w_1&=(z_1+z_2)/\sqrt{3} \\ w_2&=(-z_1+z_2) \end{aligned} \tag{8}$$

Again we note that while w_1 and w_2 are uncorrelated, the transformation (8) is no longer orthogonal.

The factor pattern now becomes

$$z_1 = .866w_1 - .500w_2 \qquad (9)$$
$$z_2 = .866w_1 + .500w_2 \qquad \sum z_1 z_2 = .500 \text{ (check)}$$

Now it is apparent that the standardized factors given by equations (4) are quite different from those given by equations (8), and a similar difference may be noted for equations (5) and (9). We have thus arrived at inconsistent solutions when the variables are standardized initially and after analysis by use of variances.

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WEIGHTED AGGREGATES AND INDEX NUMBERS

THE EXPLANATION of price indexes by the so-called "weighted aggregate" method is beset with important misunderstandings which are a natural result of the loose application of the terms "weighted aggregate" and "quantity weights." These difficulties are (1) theoretical, involving problems of definition and interpretation; and (2) practical, involving the mathematical accuracy of the results.

1. Weights, in a weighted average, must be commensurables, if the average is to have any significance. A computation may call for weights expressed in terms of tons, or of dollars, or of kilowatts, but in each case the resulting weighted average should be capable of expression as per ton, per dollar, or per kilowatt. One would expect a parallel in the case of "weighted aggregates."

This requirement with respect to commensurable weights is not fulfilled when index numbers are explained in terms of "weighted aggregates," or "quantity weights." As a result, such critics as Bassett Jones have been misled into declaiming against the whole concept of index numbers on the basis that such indexes can only represent a weighted average price per "horse-apple."[1]

Of course, if the index number concept were explained on the alternative basis of the weighted average of price relatives with weights based upon values, which are commensurables, or upon some other

[1] Jones, Bassett, *Horses and Apples*, John Day Company, New York, 1934. In fact, the comment on the jacket of the book (by Dr. Michael A. Heilperin) includes the following statement: "Mr. Jones contends that no 'price level,' either that for 1926 or for any other year, has ever been established and questions whether it is possible to determine such a general price level."

commensurable criteria, then the difficulties evaporate and, along with them, the alleged *reductio ad absurdum*.

The term "weighted aggregate" deserves reexamination because of this misunderstanding and because of other difficulties. The "sum of the (quantity) weights" is never calculated nor are the weighted totals ever divided by such a sum. Incidentally, it has never been made entirely clear whether the "weighted aggregates" are the individual pq's for each commodity or the sums of these pq's. A considerable gain would be made if terminology could be made more precise. The frequently accepted term, "aggregative method," overcomes some of the difficulties, particularly if "quantity multiplier" or simply "multiplier" replaces "quantity weights."

2. An examination of a practical index number problem reveals another source of confusion in the misuse of the term "quantity weights." In an index which undertakes to hold weights constant, it is assumed that this is accomplished by holding the quantity multiplier constant, even though it may have been necessary to make a substitution in the price series, replacing the price series for a given article with another series representing a higher grade and, therefore, a higher price for the same article. Naturally, the same "quantity weight" applied to the higher price gives a larger aggregate and hence a larger relative importance for that commodity in the final index. This is true even though the index computation employs the chain method to accomplish the splicing-in of the new price series. Under the weighted-mean-of-relatives method, price splicing would not alter the effective weight of the article in question.

A still further complication of the "weighted aggregate" method of index number computation can be cited. Assume that the relative importance (true weight) of the price observation for a given commodity is to be based upon that commodity's value in exchange. The customary procedure in the weighted aggregate method is to take the quantity exchanged and multiply by the price quotation which is to be used. But the price series may often be based upon a high or a low grade of an article, and the resulting value figure may fall far from the true value in exchange for that commodity. Quotations based on highest grade articles increase the effective weight, while prices based on low grades reduce the effective weights of commodities in the index. Examples have been pointed out in the Bureau of Labor Statistics Wholesale Price Index where the weighted aggregate figure for a given commodity or group (calculated for the year to which the "quantity weights" applied), exceeded by a considerable margin the total re-

ported value of the production of that commodity or industry in the year in question.

The examples given constitute a strong argument for statisticians, faced with practical index number problems, to employ the weighted mean of price relatives method which does not involve the difficulties presented above. The aggregative method could still be used as a convenient short-cut method, *if* used with proper care. It should be remembered that the aggregative formula[2] $\Sigma p_1 q_w / \Sigma p_0 q_w$ is identical with the weighted arithmetic mean of relatives formula[2]

$$\Sigma (p_1/p_0) p_w q_w / \Sigma p_w q_w,$$

only so long as p_0 is identical with p_w.[3] The difficulties cited should put alert statisticians on their guard whenever they say "the weighted mean of relatives, weighted by values, *or its equivalent*, the weighted (?) aggregate index number."

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GEOMETRIC PRESENTATION OF CORRELATION

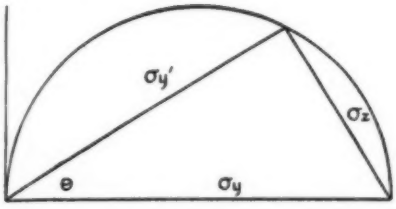
It is sometimes advisable to present the results of a correlation study (whether it be simple, multiple, or curvilinear) in graphic form so that the relationships may be seen, making explanation and interpretation easier as well as facilitating comparisons with other studies. The following method may be used as a graphic representation of r, R, or ρ.

Since $\sigma_y^2 = \sigma_{y'}^2 + \sigma_z^2$ (where $\sigma_{y'}^2$ is the explained variance and σ_z^2 is the residual variance), we can express the standard deviations as sides of a right triangle using the well known theorem that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides. To further standardize the procedure we can make σ_y in all studies always the same length. This length is made the diameter of a semi-circle within which is inscribed the above right triangle.

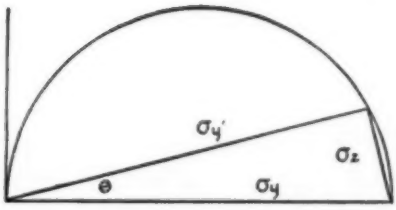
Further, r, R, or ρ is equal to $\sigma_{y'}/\sigma_y$ which in the following figures is the cosine of θ. These figures, representing two correlations, were constructed by looking up the correlation values .85 and .97 in the body of a cosine table to obtain the angle θ which was 31° 47′ and 14° 4′ respectively.

[2] "Weights" designated by subscript w.

[3] In discussing this matter with other statisticians, the writer frequently encountered the comment, "I always assumed that p_1 and p_w woud be the same." The examples given above should be sufficient to indicate that in practical index number work this is not always the case, even when base period weights are used.



r = .85



r = .97

When $\theta = 0°$, $r = 1$, since the cosine $0° = 1$; and when $\theta = 90°$, $r = 0$, since the cosine of $90° = 0$.

To present the results of a correlation study to those not versed in statistical terms, such as executives, business men, customers or clients, it is possible to remove the Greek letters and label the appropriate sides of the triangle "original," "explained" and "unexplained" and entitle the figure "A Breakdown of the Fluctuations of [*dependent variable*] Considering the Effects of [*independent*(*s*)]." To make the results even more pictorial the $\sigma_{y'}$ line may be drawn heavily in black and the σ_z line in red. It is thus very easy to see without explanation that the smaller the unexplained red line the better the correlation. This geometric method of presentation of correlation can be comprehended by the layman at a single glance.

JOHN W. MORSE

A STATISTICAL PROBLEM IN FORESTRY: ALLOCATION OF LOG YARDING COSTS ACCORDING TO LOG VOLUME*

The California Forest and Range Experiment Station, located at the University of California, Berkeley, is one of twelve regional experiment stations maintained in the major forest regions of the United States by the U. S. Forest Service. It undertakes a very wide range of problems involving statistical aspects which may be of some interest to statisticians outside of its organization. Examples of its problems are: Mathematical solutions of a road system giving the maximum territory covered for specified combined auto and foot travel time limits, and with the minimum expenditure for the roads and for fire protection on an annual and square mile basis; variance and covariance analyses of livestock grazing range inventory, forest genetics progeny tests, and timber cruise data; multiple correlation analysis

* Article suggested and sponsored by C. L. Hill, Chief, Sections of Forest Products and Economics, California Forest and Range Experiment Station.

of spread of fires as related to wind velocity and moisture content of the fuels on the forest floor (consisting mainly of the accumulated needles which fall from the trees); and allocation of log yarding cost according to log sizes.

The last mentioned problem is one of great importance to the lumber industry, to whom this research has been the means of showing that they have lost direct money on the logging and manufacture of trees below certain diameters. "Yarding," as used in this connection, is the lumbering term for the gathering of logs from the places where they lie after the tree is felled and cut into logs, to a central point where they may be bunched for further transportation by truck, railroad, or otherwise, on their way to the sawmill. In the case following, this yarding was done by tractors. The point of particular statistical interest is the method of deriving standard normal equations from expressions of the fundamental relations involved. Part of its interest arises from the fact that the process of minimizing, by which it is accomplished, is omitted or ignored by so many of the statistical textbooks.

The problem is to allocate, according to log volume, the time cost for yarding, which consists of taking tractor out to get a load, of hooking logs to tractor, of bringing the load of logs in to the landing and of unhooking the logs at the landing and turning the tractor around so that it is in position to go out for another load. Four time phases are involved: Out time, hook or assembling time, in time, and unhook-and-turn time.

While Dr. R. A. Fisher, the statistical authority of the University of London, was at the University of California giving the Hitchcock Lectures for 1936, on "The Design of Experiments," he suggested for this problem trying multiple correlation analysis, by the method of least squares and making, for the in-and-out time phase, the assumption that the in-and-out time per 100 feet of distance is a function of the number of logs on the load, the log volume, and the square of the log volume.[1] The expression to be minimized then is

$$S[T/L - b_0 n - b_1 s(v) - b_2 s(v)^2]^2$$

[1] Compare the article, "A suggested method of allocating logging costs to log sizes," by Besse B. Day, *Journal of Forestry*, 35: 1, pp. 69–71 (January, 1937). The application of the method of least squares to these problems of log movement (either yarding or transportation) was first discussed by Dr. Fisher with Miss Day in the summer of 1936. Whether the solution of such problems should rest upon diameters or volumes as the fundamental variable depends upon the nature of the individual problem—in some cases even upon the choice of the investigator. The problems covered by the two present papers, however, seem to be of the former kind. The application of the method in Miss Day's article was specifically limited to railroad transportation of logs, for which she properly chose to use diameter and diameter squared. In railroad transportation all cars travel the same distance; and the limiting factor of load is mainly one of cross-dimensional space occupied by the logs (within limiting restrictions of total load) rather than one of volume as such. This is due, first to the varying length of logs, a short log seldom permitting utilization by other logs of the volume space wasted by its own lack of length; and secondly to the difference of taper in different logs. In tractor yarding, on the other hand.

where S represents the sum; T, the time in minutes to bring logs in; L, the distance; n, the number of logs on load; v, the log volume in M cubic feet; $s(v)$, the sum of the log volumes on the load, in other words, the load volume; $s(v)^2$, the sum of the squares of the log volumes; b_0, b_1, and b_2, the regression coefficients. Minimizing is accomplished by partial differentiation of the above sum of squares of the residuals with respect to the parameters b_0, b_1, b_2, respectively, and equating to zero.

$$\left.\begin{aligned} S[(n^2)b_0 - ns(v)b_1 - ns(v^2)b_2 - n(T/L)] &= 0 \\ S[ns(v)b_0 - s^2(v)b_1 - s(v)s(v^2)b_2 - s(v)T/L] &= 0 \\ S[ns(v^2)b_0 - s(v)s(v^2)b_1 - s^2(v^2)b_2 - s(v^2)T/L] &= 0 \end{aligned}\right\} \text{Normal Equations}$$

The regression equation is $T/L = b_0 n + b_1 s(v) + b_2 s(v^2)$. Dr. Fisher proposed setting n equal to unity and then finding pairs of values of T/L and v, within the range of values for v, so that a curve might be plotted showing the relationship between cost in minutes per hundred feet of distance and log volume in M cubic feet.

In treating with the other time phases, Dr. Fisher suggested assuming that hook-and-unhook time is a function of the number of logs on the load, the sum of the log volumes and the sum of the squares of the log volumes. Now the expression to be minimized is

$$S[T - b_0 n - b_1 s(v) - b_2 s(v^2)]^2.$$

This least squares method may be adapted to many types of problems where one variable is a function of several other variables. When the parameters are linear, the solution is quite simple.

The total cost of logs delivered to the sawmill, in addition to the yarding and transportation costs includes the direct costs of felling the trees; of clearing out the surrounding underbrush, called "swamping," to facilitate subsequent work upon the tree; of cutting off the limbs, called "limbing;" and of sawing the trunk into logs, called "bucking." Besides these direct costs are of course the general or overhead costs of timber survey and appraisal, road and railroad construction and maintenance, logging camp construction and maintenance, and sundry others. Of the direct costs, however, the yarding is considerably the most complex in the number of factors which enter into it. The varying distances between position of felled logs and their landing destination, which result in a yarding load cost that is not uniform, as it is in

the solution, as in the present paper, uses volume and volume squared, with the addition of the variable L, the distance traveled. This is because in yarding the distance of travel is variable, and the in-and-out trip time is also a function of the resistance of the logs to tractor pull. The traction resistance is a function of the weight of the logs and, since the logs are of different lengths, volume is required as a variable rather than diameter. Dr. Fisher, when he visited Berkeley in October, 1936, approved the above distinction and suggested the use of the volume variable as indicated in the text.

railroad transportation, are worked up in some eight 500-foot class intervals from 0–450 to 3,500–3,950. Each of these distance classes then involves the four time-phases above enumerated, of which the solution in the case of the combined in-and-out time is indicated in detail in this paper. Finally, if different "landings," or log concentration stations, and/or different types of tractors are used in the logging operation studied, the data for each one of these variables may have to be separately classified and evaluated.

The net result of such a logging and sawmill study is, first, a curve of total direct costs, accompanied by a curve showing the additional general or overhead costs per thousand board feet of lumber realized; second, for comparison with the preceding, a curve of total money returns received from the lumber realized. These curves are plotted upon an abscissa of tree or log diameters and an ordinate of money value in dollars. The costs increase sharply toward the origin, i.e., with decreasing size of logs, due to the increasing number of logs which must be handled for a thousand feet of lumber realized, while the money values realized decrease in the same direction because of the decreasing quality of the lumber realized from small logs. The curves of cost and value therefore cross at a point of zero profit which, in the case of pine logs from California forests, is about the 20″ to 24″ diameter, depending upon the quality of the timber and the efficiency of the logging operation. Below that point the cost and realization curves diverge so sharply that, at a diameter of 12″, down to which trees were formerly cut by lumbermen, the direct money loss may be as much as $10.00 per thousand board feet. An entire logging and milling study is thus a very complicated undertaking. One such study conducted by the California Forest and Range Experiment Station involved over 30,000 Hollerith cards.

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WHAT USE IS INDUSTRY MAKING OF RESEARCH AND STATISTICS?*

A particularly rapid advance in the use of research and statistics in industry has occurred since 1920. At the present time, the large companies have come to recognize research as a proper staff effort, particularly as an

* A report by Ray D. Kinkaid of the discussion of this subject by Mr. A. T. Kearney, partner of McKinsey Wellington and Company, before the Chicago Chapter of the American Statistical Association on January 26, 1937.

aid in preventing errors in management decisions and as an aid in planning. All companies, however, do not recognize the research function in the same way in so far as its place in the organization is concerned. In some companies, the research department is given considerable dignity and prestige by reporting to a vice-president. In others, the importance of the research function has not been given comparable recognition. Its place in the organization depends primarily upon the type of business and the capability of the management to direct and use research work. Centralization of the research function has the advantage of giving it a dignity and a standing not otherwise attainable. If the research division reports directly to a vice-president or other officer on a comparable level, it aids in the creation of a realization of the importance of research. Businesses that are large and diversified in nature have to be decentralized in operation. In such businesses, research is a function of sufficient importance to deserve a centralized set up and a dignified status in the organization.

There is, of course, no standard by which one can measure the effectiveness of research as an aid in business problems. In attempting to measure its value, the best assumption is that business is a cooperative effort instead of an individual effort. If the management of a business takes the best steps possible, it is likely to be the result of the pooling of ideas originating both in the research department and in the line organization.

The more rapid progress in the use of statistics and research in recent years has occurred because of a recognition that an activity to be of value must be attuned to the needs of the management of a business and must be accepted thereby if it is to perform a useful function. Research is being accepted as an indispensable function in business organizations because good business management requires more than the unsupported judgments of busy line executives. The acceptance of research as an aid to business managements has been furthered by a definite change in the mental attitude of executives in the last twenty years. Executives are now more open-minded in their attitude toward outside help. Human nature may not change but human attitudes do change. These changes in attitudes include the growth in the spirit of inquiry, the willingness to experiment, and in the desire to delve for truths. Executives who operate entirely on an empirical basis are now less satisfactory. This change in the mental attitude of executives is of primary importance since research can go only as far in fulfilling its functions as the general attitude of the executives permits. Research, of course, can flourish only as an appendage to something else, and not for its own sake alone.

The more open-minded attitude of executives toward research has resulted in large part from the push of circumstances, and the observance by executives of the phenomena of change around them. Executives found themselves faced with problems they didn't know how to handle. Influences both internal and external complicated the problems of management and made it necessary for the busy line executives to get help from somewhere. Of per-

haps greatest importance among these influences was the growth in the size of businesses. Previous to the growth of business into large units, the only farflung enterprise was the army. The staff function has been recognized in the army for years. As businesses grew in size, it was only natural that an accompanying growth in the staff functions, including not only research, but also control and personnel, should occur. The staff functions are here to stay as long as business remains as complex in nature as it is today.

There has been a good deal of lost motion in the development of research to the point where it is of service to business. Two reasons might be given for this lost motion. The first reason which might be cited is the attitudes or limits of the executives research is trying to help. It is not a good excuse, however, to say that the people one is associated with are too dumb to learn or unwilling to accept needed research assistance. At the least, such an excuse would be a reflection upon the salesmanship of the person involved. The general tendency has been to overemphasize the importance of knowledge and to underemphasize the mental attitudes involved. It is essential in research work to meet wrong attitudes of mind and to overcome them. The second reason is that we research workers haven't understood as well as we should the problems with which business executives have to deal. We haven't understood what is involved in the job of an executive. Staff men differ from line men in being of a more studious and reflective nature. He fears that if he acts hastily he'll be wrong, while a line executive has to make many decisions quickly. An ideal research worker is one who understands the job of the executive, is able to do research work, and is able to sell the results of research work to the executives. It is essential that staff people have a better comprehension of what the business executive has to do!

The research function can be an aid to the executive largely in connection with the formulation of policies. The whole job of policy making, however, cannot be gotten out of the research department. There are three requisites to policy making, as follows: inspirational thinking, interpretation of experience, and research or analytical thinking. The last involves checking the accuracy of the conclusions reached by the other two types of thinking. Original thinking in the business field is comparatively rare. Original thinking, however, is usually found in the development of large and outstanding businesses. The research worker, however, does not have a monopoly upon original thinking. He can only hope to contribute to policy making.

In understanding the job of the executive, the research worker must recognize that executives must get things done. In filling his job, it is necessary for the executive to understand the validity of facts and correlate them, to evaluate and interpret experience, to direct and coordinate people, and to strike a good balance between time and accuracy. These four points constitute a good definition of the word "executive." It would be a great advantage in selling research work if research workers would try to gain a better and more sympathetic understanding of what the executive expects from him. This involves understanding the whole question of business manage-

ment. For executive use, reports must be brief. The executive doesn't care about the methods used but is primarily interested in the results. For an executive to be sold on research work, he must have confidence in the research workers. Such confidence develops from the degree with which the research worker's results check with his own independent thinking. The research worker should be a good psychologist, and find out how the executive wants things presented and thus save the time of both.

In answering the fourth question, dealing with the opportunities involved in the further development of the use of research in business, Mr. Kearney said that if he interprets the signs of the times right, there is an increasingly great emphasis in business on the point of view and the contribution the research worker is supposed to bring into business. The need for research workers is going to be great and the opportunities for research workers are going to be great. There is first the opportunity for developing professional prestige in the research and statistical field. Research workers will also have opportunities for promotion to executive positions, and Mr. Kearney expects to see a good many executives drawn from the research field in coming years. Research, particularly in the marketing field, is too young to have permitted the development of executives through that channel but the time, however, will come when executives will be drawn therefrom. The research worker has the advantage of broad contacts in the business, the chance to develop a wide acquaintanceship in the business and a broad knowledge of the problems involved in the business. People get ahead by making people think well of them. Research provides a good opportunity to workers in the field to let people know them. It gets down to the question of individual development. The first requisite in research workers getting ahead is an inquiring mind, the second is an open mind, and the third is his qualities and effectiveness in action. These are the same qualities that are essential in the successful executive.

STATISTICAL DISCUSSIONS AND RECOMMENDATIONS OF THE WORLD TEXTILE CONFERENCE

A World Textile Conference was held in Washington, D. C., in early April, 1937. It was called by the International Labor Organization and was attended by delegates and advisers and two observers representing every important textile producing country in the world with the single exception of Italy.

The Conference was called in order to survey all of the international economic problems of the textile industry. It had before it an elaborate study prepared by the I.L.O. entitled "The World Textile Industry."

While other committees of the Conference were debating the conclusions that might be drawn from the facts presented in the Report, a Statistical Committee considered the adequacy and accuracy of the statistical material contained therein. The delegates considered that the Report had done as

much as could have been done in the short period available to fairly present the statistics that had been presented in different countries, but they were dissatisfied with the figures for two reasons. In the first place, it was frequently impossible to make international comparisons of statistics because terminology and classifications in different countries were so varied. In the second place, there were many gaps in the information because neither Governments nor employers had been regularly collecting some of the more significant data. The recommendations of the Statistical Committee were designed to meet both of these deficiencies.

The discussion in this Conference of the 40-hour week in the Textile Industry had to be based on quite inadequate data. For seven years the International Labor Office had been attempting to secure an agreement between countries on the basis of which it could make international comparisons of certain labor data but Governments had been unwilling to cooperate in it. In 1937, however, a new atmosphere was apparent. The statistics discussion was carried on within the framework of an entire and inclusive consideration of the serious derangement of the textile industry and the low labor standard that had resulted. Delegations that were debating the difficulties or possibilities of international agreements towards improved labor conditions in industry were less reluctant than their Governments had previously been to cooperate in the collection of basic statistical information.

The report of the Statistical Committee, accepted by the full Conference, proposed that the I.L.O. circulate a questionnaire to secure certain basic labor data. It calls for the total number of workers in each branch of the industry, and for an adequate sample of each branch, the total number of workers on the pay roll and their total wages, and total normal and actual working hours in one week. All of this data is to be classified by sex, and into three age groupings. From such raw data average hourly rates and weekly earnings and average actual and full time weekly hours are to be computed. The questionnaire also will request data on the character of the mechanical equipment in the industry.

The Committee recommended that such figures make a distinction between factory and outside employees, that to them be added data on the number of workers in two and three shift operations, that the overtime and night rates be compiled and that each national statistical agency compute a frequency distribution of plant average actual hours. It also recommended that a national authority take particular care to make its sample representative both geographically and by size of plant.

The Conference recommended that a survey of this nature should be repeated each few years. In addition to wage and hour information, it considered that the study include reports on the ratio between total pay rolls and value added by manufacturer, upon employment and unemployment in the industry and upon the mechanical equipment of the industry.

In addition to such a periodical survey the Conference favored the collection of more frequent reports upon the total man-hours, total wages and

total number of employees of a representative sample of the main branches of the industry.

In considering the economic data presented in the Office Report, the Statistical Committee made a number of recommendations concerning the gaps that are apparent in the national reporting of production, import and export and consumption data. It recommended a classification of such data that would facilitate international comparison. Of fundamental importance in the discussion of the international economic problems of the industry the Committee considered data upon costs of production. It found the most serious gaps in the statistical information available in connection with such costs. It therefore recommended that upon a few typical items clearly specified costs of production be secured from representative firms in different countries. This recommendation was opposed by the representatives of a number of employers but the Committee felt that on the basis of the support given the idea by the Government and employer delegates from the United States, Japan, and Canada that the study might be usefully attempted.

Although the Conference proved to be a useful step forward in several directions in grappling with the problems of the industry it can be said that one of its most important contributions was its discussion of the available statistical materials. From its recommendations in this field should come a much more elaborate and useful series of data upon both labor and economic aspects of the industry. Regardless of the outcome of the 40-hour week Convention for the textile industry that is to be debated at the June Conference of the I.L.O. the statistical work done by the preliminary Conference in Washington is certain to be of enormous importance to the individual countries and for future planning on an international scale for the textile industry.

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APPLICATION OF STATISTICAL METHODS IN THE AMERICAN SOCIETY FOR TESTING MATERIALS

The American Society for Testing Materials recently announced a new printing of its *Manual on Presentation of Data* which includes, in pamphlet form, material of an essentially statistical character that has been prepared for use in the various standing committees of the Society.

The Manual is an outgrowth of activities of the Society's Technical Committee on Interpretation and Presentation of Data which was formed early in 1930 in response to a growing demand for more widespread application of statistical methods to the special problems of the Society. This committee now has a membership of over forty, consisting of regularly designated representatives of standing committees and so-called special adviser-members in the ratio of about four to one.

The principal activities of the Society—the accumulation of knowledge of engineering materials and the standardization of specifications and methods of testing—are peculiarly adapted to the application of statistical methods. The physical or chemical properties of any material, or of any batch of material can only be expressed by the results of testing portions, specimens or samples of the whole. The establishment of specification limits to be met by individual specimens and of acceptance criteria to be met by the test results of samples to be selected from shipments or lots of product, inherently involves questions of variability from specimen to specimen and from lot to lot. In preparing standard specifications for material or product yet to be made, a committee can proceed in a more sure-footed manner if there is available some quantitative information as to how the material will behave under different conditions and how closely the variations in its properties can be controlled at reasonable cost under the normal operating conditions of a well-equipped plant. Analysis and summarization of the data of past experience is commonly an important phase of specification work, particularly since it is the aim of a producer operating under a specification to produce the same thing again and again. The problems of specifying and producing engineering materials and of judging their quality generally deal with "repeated series of like events occurring under generally like conditions," a situation which is especially susceptible to statistical treatment. It is but natural that the method of approach should differ somewhat from that required in treating results for an isolated sample from an isolated "universe."

The main section of the Manual treats the descriptive aspects of statistical methods, discusses frequency distributions and the more commonly-used statistics, such as the arithmetic mean and the standard deviation, and gives a number of short-cut methods of computation. Stress is laid on the importance of using efficient statistics to express that part of the total information contained in a set of observations, which is essential to the intended use of the data. The first Supplement gives a suggested procedure for presenting plus-and-minus limits of uncertainty of an observed average, and discusses the problem of number of places of figures to be retained in presenting results. The second Supplement gives formulas and tables useful in applying the "control chart" method (developed by Shewhart) of analysis and presentation of data obtained from several samples. A number of illustrative examples are given to indicate how the recommended procedures may be carried out in practice.

It has been the policy of the Technical Committee to make available in the form of supplements to the Manual, additional material of a statistical character which the Society considers of general interest to its members.

H. F. DODGE, *Chairman*

Technical Committee on Interpretation
and Presentation of Data, A. S. T. M.

HANDBOOK ON SOURCES OF ECONOMIC DATA PERTAINING TO CALIFORNIA

A Handbook on Sources of Data pertaining to California is being compiled by the Research Department of the California State Chamber of Commerce. This reference manual will give a brief description of the principal fact-finding agencies that compile and/or publish economic data pertaining to California, and will contain a comprehensive index of the information available from these agencies. Primary and secondary sources will be included in the agency section of the Handbook, covering the various federal, state, county, and municipal departments, bureaus, and divisions; universities, colleges, foundations, etc.; and commercial organizations such as trade associations and chambers of commerce, independent companies, banks, advertising agencies, publishers, independent research and statistical organizations, etc.

A wealth of economic information pertaining to California has been and is being collected by public, semi-public, and private agencies embracing nearly every aspect of economic and social life. The mass of facts thus assembled is so great and diversified that it is difficult to know what data are available and what agencies collect or disseminate the desired information.

One of the greatest barriers limiting the use of economic information by business men and organizations is the lack of knowledge as to what facts are available, where they are, and how and where they may be obtained. Also, in nearly every investigation, much time, effort and money is spent by many searchers, and even trained research workers, in locating the proper source of the data needed. This source-book is planned as a guide to agencies compiling and/or publishing economic facts pertaining to California that are generally available to research workers, librarians, business men, instructors, etc.

In the description of the agency will be included: (1) Name and address, (2) date of establishment, (3) addresses of the agency's California offices, departmental units and/or representatives, (4) a brief summary statement of the main objective(s) of the agency, (5) a condensed statement of (a) the nature of economic research work done, being done and to be done, and (b) the kind of economic data collected and/or published by it, (6) agencies working in conjunction with it, and (7) where and how the information may be obtained.

The second part of the Handbook will be an index of the facts and statistics available to research workers from the agencies described. Index references will be by number to the source agencies. The completeness of the index, however, will depend primarily upon the amount of information contributed by each agency solicited.

The method of obtaining the information for the Handbook is by questionnaire, supplemented with suggestions, illustrations, and a letter. The list of agencies receiving the questionnaire was compiled from suggestions

secured from over forty persons interested, either directly or indirectly, in economic research. In the office files, a separate folder was made for each agency which contains the correspondence, the information received, and a record of the progress of editing and indexing. In cases where the replies are insufficient or inadequate, further investigation is made either by correspondence or interview. Before mimeographed copies are made of the edited reports of the agencies for inclusion in the Handbook, a typewritten copy is sent to the agency for correction and/or approval.

It will be some time before the final report is released. While all of the agencies on the original list have been sent questions and many replies have been received, new sources are being uncovered to which questionnaires are being sent. Also, the need for further correspondence for additional information is postponing the date of issuance of the final report.

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FEDERAL ACCIDENT STATISTICIANS

A group known as the Federal Accident Statisticians, composed of representatives of those Federal Governmental agencies engaged in accident prevention and reporting, has been organized in Washington. The first meeting was called in September 1935 by Sidney W. Wilcox, chief statistician of the Bureau of Labor Statistics, for the purpose of obtaining the opinion of Government statisticians on technical aspects of the American Standards Association's proposed standard for compiling industrial injury rates. It was decided to organize and hold future meetings for the purpose of discussing matters of mutual interest to the members. Mr. Wilcox was elected chairman, and Swen Kjaer, chief of the Division of Industrial Accident Statistics of the Bureau of Labor Statistics, was named secretary. The members of the program committee are Halbert L. Dunn, chief statistician, Division of Vital Statistics, Census Bureau; W. W. Adams, head of the Employment Statistics Section, Bureau of Mines; and Edward Crane, statistical analyst, Bureau of Statistics, Interstate Commerce Commission. The list of people who have participated in the meetings now numbers over 70, and 27 agencies are represented.

Among the speakers who have addressed the Federal Accident Statisticians are Leonard W. Hatch, chairman of the American Standards Association's sectional committee on standardization of methods of recording and compiling industrial injury rates, who reviewed the development of the proposed standard with particular reference to the rule as to inclusion of temporary disabilities; Max D. Kossoris of the Bureau of Labor Statistics, who spoke on the Bureau's new approach to the analysis of industrial injury rates; and H. W. Heinrich, assistant superintendent of the Engineering Divi-

sion of the Travelers' Insurance Company, whose subject was the statistical technique required for accident causes. Mr. Heinrich is chairman of the American Standards Association's sub-committee for revision of the cause code.

PROGRESS OF WORK IN THE CENSUS BUREAU

ANOTHER CENSUS OF RELIGIOUS BODIES

The Act of 1902 establishing the permanent Census Bureau names "religious bodies" in the list of subjects on which the Director of the Census is authorized to collect statistics decennially following the completion of each main decennial census; and under that authorization the Bureau has taken three censuses of religious bodies, covering, respectively, the years 1906, 1916, and 1926, and is now taking the fourth covering the year 1936.

The method by which the statistics are being collected is similar to that employed in the preceding censuses. A list of church organizations is obtained from yearbooks or other denominational publications. This is supplemented by correspondence with the central office, if there is one, or with ministers and other officials of the denomination. When the mailing list is completed, a schedule is mailed to the pastor, clerk or other official of every church, with an official envelope for his reply. The census of 1926 covered 212 denominations and 226,718 churches.

The questions on the schedule include the total number of church members by sex, and the number of church members under 13 years of age; also the number and value of church edifices, and debt on the same. Church expenditures are to be shown in greater detail than ever before, being itemized as follows: pastor's salary; other salaries, repairs and improvements; payments on church debt, excluding interest; local relief and charity; all other current expenditures, including interest; home missions; foreign missions; amount sent to general headquarters; other purposes. The numbers of officers, teachers, and pupils in church schools are to be given distinguishing Sunday schools, summer vacation Bible schools, week-day religious schools, and parochial schools. A new question in this census asks for the average church attendance per Sunday.

In the preparation of the schedule the Bureau consulted the American Association of Statisticians of Religious Bodies, the International Council of Religious Education, and many individuals representing large religious denominations.

The schedules are now being sent out, and the returns are coming in. It is expected that the data will be tabulated and the reports published before the end of the year 1938.

COMPLETION OF THE 1935 CENSUS OF BUSINESS

The 1935 Census of Business is now completed. The reports, which were printed by the multilith process, comprise 35 volumes, having a total of about 2,600 pages. There are 6 volumes on retail trade, 8 on wholesale trade,

3 on construction industry, 3 on service establishments, and one each on banks, financial institutions other than banks, insurance, hotels, places of amusement, bus transportation, motor trucking for hire, public warehousing, radio broadcasting, advertising agencies, distribution of manufacturers' sales, retail trade survey, and miscellaneous business. A booklet, "Business Census Publications," giving a brief description of the content of each volume may be obtained on application to the Bureau of the Census. A series of special studies on various phases of retailing and wholesaling will follow the publication of the regular reports.

The basic data tabulated in this census include sales or receipts, operating expenses, number of proprietors and firm members, number of employees, and pay roll. The number of employees was returned by months. The main statistical items, including regularly the number of establishments, total sales or receipts, number of employees and pay roll, are as a rule shown by states and for principal cities; and in case of retail trade and of service establishments they are shown by counties also and for every city or other incorporated place within the county having more than 2,500 inhabitants.

This census, it may be recalled, was financed by funds supplied by the Works Progress Administration; and except for the technical and supervisory force, all the employees for both field and office force were taken from the relief rolls. The office force at the headquarters in Philadelphia, where the returns were received and tabulated and the results printed, reached a maximum of 1,825. The total force employed in the field was about 16,000. The field canvass was started on January 2, 1936, and completed on October 30, 1936.

THE NEW ADVISORY COMMITTEE

The first meeting of the reorganized Census Advisory Committee was held in Washington on April 2 and 3, and was devoted mainly to acquainting the members of the Committee with the organization of the Bureau giving them the opportunity to meet the heads of the various divisions and to learn about their work, functions, and problems. As the organization of this committee represents in some respects a new departure, a brief reference to the history and origin of the antecedent committee may be of interest.

The original Census Advisory Committee was created in 1918 at the request of the Secretary of Commerce, who addressed identical letters to the Presidents of the American Economic Association and the American Statistical Association requesting the appointment of a committee "to be advisory to the Director of the Census and the Department of Commerce in connection with the work of the Fourteenth Census." It may be of interest at this time to recall what the membership of that committee was. It comprised William S. Rossiter, Chairman, Carroll W. Doten, and Edwin F. Gay appointed by the Statistical Association; and Walter F. Willcox, Wesley C. Mitchell, and E. R. A. Seligman appointed by the Economic Association. Later Allyn A. Young was added to the membership.

With the completion of the Fourteenth Census in 1922 the purpose for which this committee was originally appointed had been fulfilled. But at the request of the Director of the Census the committee was reconstituted and made permanent, consisting as before of three members from each of the two associations but with the term of office limited to three years, two members going out each year. This was the basis on which the committee operated up to the end of last year, when it was decided with the approval of the Director and of the executive boards of both Associations to have the entire membership of the committee appointed by the Statistical Association. Accordingly, at the January meeting of the Directors of the American Statistical Association appointments to the new committee were made as follows: Robert E. Chaddock, Chairman, Frederick C. Mills, William F. Ogburn, Murray R. Benedict, J. Frederic Dewhurst, and Paul T. Cherington.

J. A. H.

STATISTICAL NEWS AND NOTES

CENTRAL STATISTICAL BOARD.—The President transmitted to the Congress on March 9, the Second Annual Report of the Central Statistical Board covering eighteen months ending June 30, 1936. (Copies may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C., at ten cents each.)

The Bureau of Agricultural Economics and the Central Statistical Board are cooperating in a study of the problems involved in conducting a sample census of agriculture. Mr. J. J. Morgan, of the Bureau of Agricultural Economics, is directing the study and a committee composed of Mr. Frederick F. Stephan, Chairman, Mr. Charles F. Sarle, Mr. Z. R. Pettet, and Mr. Morris A. Copeland, has been established by the Central Statistical Board, to advise Mr. Morgan.

DOMINION BUREAU OF STATISTICS, CANADA.—*1936 Census of the Prairie Provinces.* Since the last interim report of January 25, 1937, the Census Branch has published a bulletin in connection with the quinquennial census giving the population by geographic divisions of these provinces and also a statement of rural and urban populations by census divisions. The coding and punching of the occupation and agriculture cards are now completed and tabulations are well under way. Final compilations of both population and agriculture are expected to be ready for publication in the near future.

Social Analysis Branch. This division is working on, and has practically completed, a project for the compilation and publication of official life tables for Canada and its various geographical divisions (provinces and zones, etc.). Extension of the work to a series of tables having particular reference to earnings, employment, dependents, etc., is in progress.

Agricultural Branch. This Branch has recently issued a report surveying world trade in wheat for the latest 10 calendar years, 1926 to 1935. The report is divided into two parts: Part I deals with world exports and imports of wheat by individual countries. Charts are included which depict the share each country contributes to the world exports and imports respectively. Part II deals with the chief importing countries, the compilation showing the sources from which such imports are obtained. Tariffs and restrictions in force in each importing country are described. The publication has been prepared primarily for those engaged in the grain trade, but it should prove valuable for reference purposes generally.

Transportation and Public Utilities Branch. With the organization of the Dominion Department of Transport, statistics on air transportation and air harbours, which formerly have been compiled by the Aviation Branch of the Department of Marine, have been transferred to the Dominion Bureau of Statistics and these will be published hereafter by this Bureau. The first report to be issued will cover operations for 1936.

Education Statistics Branch. This branch of the Bureau of Statistics is

working in collaboration with the National Film Society, the Canadian Broadcasting Corporation and the National Gallery of Canada, in the study of the use of auditory and visual teaching aids in Canadian schools. A similar survey in the United States was recently made by the Office of Education, Washington.

General Statistics Branch. The seasonal indexes used in the compilation of business statistics have recently been revised to reflect important influences developed in recent years; the index of the physical volume of business and its components, have been recomputed for 1936. The number of factors used in this index is now 46.

DIVISION OF RESEARCH AND STATISTICS, BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM.—Results of a recent survey made by the Board of Governors and the Federal Reserve banks with regard to interest rates charged by member banks were published in the April 1937 issue of the *Federal Reserve Bulletin*. The survey was made as of October 1, 1936, and compares for different groups of banks interest rates they charge to the greatest number of borrowers and on the largest volume of loans of various types, such as commercial and industrial loans, agricultural loans, loans on urban commercial and on urban residential property, and loans on farm real estate.

The Board of Governors has revised the form on which member banks in 101 leading cities report their items of condition each week, effective as of May 12, 1937. Changes in the report are confined to the classification of loans and discounts, so as to include two significant classes of loans not previously shown separately, namely, (1) commercial, industrial, and agricultural loans and (2) loans (other than to brokers and dealers) for the purpose of purchasing or carrying securities, in addition to open-market paper, loans to brokers and dealers in securities, loans on real estate, loans to banks, and loans not otherwise specified.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.—The Bureau's *Survey of Current Business* for May and June carry special articles which should be of interest to readers of the JOURNAL. The May article presents the Bureau's new index of grocery chain store sales, which is discussed in considerable detail, showing the composition of the sample, the per cent coverage in relation to total chain store sales, the adjustments for various seasonal factors, variation in daily sales, the relative amount of business contracted on the different days of the week, etc., and a chart comparing the movement of sales and the retail food prices. The monthly index is being carried forward as a regular feature in the *Survey*. The article in the June issue presents the Bureau's annual estimates of national income, which are broken down by types of payments and by industries. Reprints of both of these articles are available upon request to the Bureau of Foreign and Domestic Commerce.

The *World Economic Review*, published annually in one volume by the

Bureau in 1934 and 1935, will, for the 1936 issue, be released in two parts. The first part, released in June, contains a statistical analysis and discussion of the economic developments and trends in the United States during 1936. Such subjects as prices, manufacturing and mining, electric light and power, agriculture, construction, transportation and communication, domestic trade, foreign trade, employment and pay rolls, and finance are included in separate sections of the volume. Each section was prepared by a specialist in that particular field and a liberal use of charts has been made. Three interesting appendices are attached: Appendix "A" presents a chronology of important economic events in 1936, Appendix "B" digests legislation enacted by the second session of the 74th Congress and presents in summary form the most important laws of an economic character, Appendix "C" presents in tabular form comparative data from 1929–1936 inclusive covering the more significant indicators of economic change. The second part of the *Review*, which will deal with the economic developments and trends abroad, will be published later.

The Finance Division of the Bureau will have available for distribution during the early summer two publications of wide interest, the annual study of the *Balance of International Payments* and a study of *Foreign Investments in the United States*. The former study, which will cover 1936 data, is the fifteenth consecutive report on the *Balance of International Payments of the United States* to be published by the Department of Commerce, and represents primarily a compilation of our international transactions from the standpoint of commerce, banking and foreign exchange. The second of these publications will present a detailed analysis of foreign investments in the United States by types (stocks, bonds, etc.) and will show both the nations and industries represented. Certain historical background taken from early estimates and other sources and brought up to date will be presented, as well as a qualitative analysis of the various types of investments.

The Bureau of Foreign and Domestic Commerce has for some time been devoting considerable attention to construction economics, and is at the present time preparing annual estimates of the dollar valuation of construction in the United States. Particular attention is being given to the development of logical categories of classification according to ownership, use, and the separation of new works and structures from maintenance and repairs. Wherever possible reported outlays will be used and land and mobile equipment will be excluded.

Several articles by Bureau officials which deal with construction have recently appeared. One, *The British Housing Problem* by Dr. N. H. Engle, Assistant Director of the Bureau, and two by Lowell J. Chawner, Chief of the Construction Economics Section, presenting *Basic Factors in the Trend of Construction* and *Economic Factors Related to Residential Building*. Reprints are available upon request.

The annual study of the Foodstuffs Division on confectionary production and distribution was issued in May. This study which covers 1936 data has

several new features; principal among these is a table showing the percentage of sales made monthly for each year beginning with 1928 and carried through 1936 for an identical group of manufacturers. Other features include an analysis by types of manufacturing establishments (specialty manufacturers, general line manufacturers, etc.) and the extent to which total production is represented by the manufacturer's particular type of product, raw material prices analyzed to determine their effect on average value of goods manufactured and on future prices, and a breakdown of the retail price at which bar goods are packed for sale.

The Chemical Division's annual review of world chemical developments will be issued shortly. This volume contains data for all countries of any importance in the chemical field, either as producers or consumers, and deals with such topics as production, employment, prices, new products, significant developments, governmental aids, trade restrictions, etc., for about forty-five individual nations.

The Bureau's annual *Retail Credit Study*, which was announced in the last issue of the JOURNAL, is now in the hands of the printer. This study covers 1936 data which are based on a larger sample than the previous annual surveys, and presents 1935 and 1936 data on cash and credit sales by credit granting stores, installments, collections, bad debt losses and other factors of importance by cities for fourteen important kinds of retail trade. Another publication, "Sources of Current Trade Statistics," is a valuable reference guide as to what current statistics are available, where published, and the frequency of issue.

INTERSTATE COMMERCE COMMISSION.—The Bureau of Statistics has under consideration at the present time the revision and improvement of the commodity traffic statistics of the Interstate Commerce Commission. In addition to discussion with representatives of the railway companies as to the practicability of further breakdowns of existing data, the suggestions of various organizations using these statistics will be invited. The American Marketing Association, at the suggestion of the Bureau, has appointed a committee of three members to prepare a report on Interstate Commerce Commission traffic statistics.

As a part of the semi-centennial celebration on April 1 the Commission has released a new publication of some five hundred mimeographed pages entitled "Interstate Commerce Commission Activities, 1887–1937." This historical summary was prepared by the Bureau of Statistics in cooperation with the various other bureaus of the Commission, each of which furnished a memorandum of the growth and development of its individual activities.

FEDERAL TRADE COMMISSION.—A report entitled "Agricultural Income Inquiry, Principal Farm Products," was made to Congress by the Commission early in March. This was pursuant to Public Resolution No. 61, 74th Congress. The principal farm products, selected as the basis for this study, included wheat, cotton, tobacco, livestock (cattle and hogs), and milk. In addition a special study of potatoes was made.

The subjects treated in connection with the various farm products were: comparison of gross income of farmers and of manufacturers and distributors of farm products; farmer's, manufacturer's and distributor's respective shares of the consumer's dollar; extent of concentration and control in the manufacture and distribution of farm products and their manufactures; methods of acquiring control of manufacture and distribution; farmers' cooperatives; market manipulation of grain; cottom markets; growth of capital, earnings and rates of return of processors and distributors; channels of supply and distribution; salaries of corporation officers; and tax avoidance by corporations and by corporation officers in respect to their salaries.

The report has not yet been printed but is available for examination at the Commission's offices. A summary of the report, together with conclusions and recommendations, in mimeographed form may be obtained from the Commission.

By direction of Public Resolution No. 112, 74th Congress, the Commission has extended the Agricultural Inquiry to fresh fruits and vegetables, table and juice grapes. Already an interim report in the matter, together with tentative recommendations for legislation, has under the terms of the resolution been made to Congress. This has been printed. The inquiry is following along the lines of that made on principal farm products and will be completed the last of May.

In the inquiry made by the Commission in response to Public Resolution No. 130, 74th Congress, costs, profits and prices of concerns engaged in the manufacture, distribution and sale of farm machinery are being investigated. Reports have been received from upwards of a thousand dealers and information on the prices of American-made agricultural implements has been received from American consuls at Pernambuco and Rio de Janeiro, Brazil; Calloa and Lima, Peru; Capetown, South Africa; and Havana, Cuba. One branch of the inquiry is devoted to a study of the methods of distribution, including competitive conditions.

BUREAU OF AGRICULTURAL ECONOMICS.—Dr. J. Neyman, reader in statistics at University College, London, and founder of the statistical laboratory at the Central College of Agriculture in Warsaw, delivered a series of lectures April 6–10 under the sponsorship of the Graduate School of the Department of Agriculture. He lectured on certain fundamental notions in the application of probabilities, the selection of statistical tests, and problems of sampling. He also discussed the application of statistical methods to various problems of importance to the Department of Agriculture, and held a series of special conferences with members of the Department. The subjects of these conferences included the simple theory of confidence intervals, correlation analysis of time series, certain problems in plant breeding, randomized and systematic arrangement of field experiments, and practical and theoretical aspects of estimation. It is the plan of Dr. A. F. Woods, Director of the Graduate School, to bring in one or two leading men in the field of statistics each year for similar series of lectures.

The Statistical Committee of the Bureau of Agricultural Economics has continued its examination of the statistical work of the Bureau. Subcommittees have been engaged in a study of the adequacy and reliability of the statistical series regularly compiled by the Bureau. The use and misuse of correlation in the analysis of time series, particularly prices, also continues to be the subject of study in the Bureau.

FARM CREDIT ADMINISTRATION.—About three years ago statisticians were appointed in each of the twelve Farm Credit Administration districts and since that time research in the field of farm credit and related problems has developed rapidly. Each district statistician is directly responsible to the general agent in his district and is thereby able to serve all credit units in problems involving statistical and economic analysis. Although there is rather wide variation in the kinds of work done in the different districts, about one-half of the work has been basic research on farm credit problems, and the remainder has related to current operating problems of the credit units and to reports on the current economic situation in the district.

Research has progressed further in the field of long-term farm mortgage credit than in short-term credit problems. A large amount of statistical information has been compiled and analyzed to show loan history and general experience of the Federal land banks. Studies are now being made of selected small areas to determine the effect of various factors on the success of loans by Federal land banks. However, it is expected that in the future more attention will be given to research in short-term loans to farmers.

The Economics Subdivision of the Farm Credit Administration in Washington, D. C., follows closely the activities of statisticians in the districts in order to give suggestions, exchange ideas between statisticians, and coordinate the type of work done. On the whole, however, a policy has been followed of placing responsibility on each district statistician for decisions relative to the type of work to be followed in the district. This policy makes the statistician an integral part of the district organization.

In addition to coordinating work on the statisticians, the Economics Subdivision is developing a program of fundamental research in farm credit problems. Some projects will be developed in cooperation with district statisticians and others will be carried on independently by professional members of the Washington staff. E. C. Johnson, formerly of the University of Minnesota, was recently appointed Chief Economist in charge of the Economics Subdivision of the Farm Credit Administration.

Research in agricultural credit by other agencies is being encouraged by the Farm Credit Administration. The Economics Subdivision and statisticians in the districts have cooperative projects with five agricultural colleges now in progress and it is expected that more projects will soon be developed involving other colleges.

BUREAU OF LABOR STATISTICS, U. S. DEPARTMENT OF LABOR.—Owing to the widespread interest in the cooperative movement and the lack of recent

statistics showing its extent, a general statistical survey of activities in the United States has been undertaken. This is in continuance of previous surveys of the Bureau, made at irregular intervals over a period of some twenty years, but will be a more comprehensive investigation than has previously been possible. It embraces all types of consumers' societies, as well as housing, insurance, credit, and workers' productive organizations, but will not include farmers' marketing associations except in so far as they handle consumers' goods.

A comprehensive redistribution of the rent sample used in the Bureau's cost-of-living indexes is being planned. The need for reworking this sample arises from the fact that no complete reconsideration of the houses for which rents are collected has been provided for since the houses were originally selected at the time the 1919 cost-of-living survey was made by the Bureau. As houses have fallen into disuse or been torn down the necessary number has been added from among those in the respective communities of a similar type.

The wage work projected at this time includes an investigation of wages and hours in the cotton textile industry which will probably be as of a March 1937 pay roll period and represent a twenty per cent sample of the entire industry. Wage rates of workers in both the union and nonunion branches of the building trades are also being obtained. The finished report will cover the conditions in 105 cities.

In the series of studies of labor requirements in various industries, of which the latest published report deals with lumber production, the labor requirements in brick making, transportation, and production of plumbing and heating equipment will be the next to be measured.

Activities and methods of procedure of government agencies of all kinds are being surveyed to ascertain what work is being done in the interest of labor and the methods and personnel through which the agencies operate. This entails study not only of state departments of labor but of those dealing with related subjects, such as vocational education and rehabilitation, industrial hygiene, and mining. State, federal, and federal-state agencies acting under recent legislation are included.

UNITED STATES EMPLOYMENT SERVICE.—*Series of Comprehensive Analyses of Active Job-Seekers Continued.* The series of comprehensive surveys of the characteristics of all persons actively seeking work with the United States Employment Service, which was begun in 1935, is being carried forward with a detailed analysis of some 6¼ million applicants who were actively seeking work through the public employment offices on April first. These surveys, which are prepared by the Division of Standards and Research, give detailed information concerning the occupational classification, industrial background and year of birth of all active job-seekers, with cross-classifications by sex, color, veteran and relief status. A complete geographical breakdown of all information is provided in units as small as counties.

The results of the first two surveys of this type were recently published

under the title *Who Are The Job-Seekers?* This publication, which was released in April, was accompanied by a similarly detailed report of registration and placement activities over a two-year period under the title *Filling Nine Million Jobs*. Each publication includes a narrative account and extensive tables and charts.

DIVISION OF PLACEMENT AND UNEMPLOYMENT INSURANCE, NEW YORK STATE DEPARTMENT OF LABOR.—A current statistical task of the Bureau of Research and Statistics has to do with the organization of local employment offices for the combined functions of placement and unemployment insurance administration. In order to determine the space and personnel required for the expansion of the employment service throughout the State, the Bureau has been engaged in estimating, for specified geographical subdivisions of the State, the 1938 population, the gainfully occupied population by industry groups, the insurable workers by industry groups, and the probable number of users of local office services in 1938.

The Industrial Classification Code originally developed by the Division has, with some revisions, been adapted by the Social Security Board for use in other states having unemployment insurance laws and for the classification of old age benefit records secured from employers. The Bureau of Research and Statistics is now giving attention to objectives and procedure in the subclassification of the major groups of the present code, to serve the analytical needs of placement and unemployment insurance administration and research.

DIVISION OF RESEARCH, STATISTICS AND RECORDS, WORKS PROGRESS ADMINISTRATION.—*Works Program Statistics.* The March 1937 issue of the Report on Progress of the Works Program has been released. This report reviews the operations of the Works Program since its initiation in April 1935. A summary of the efforts to provide security for the unemployed and other groups in need indicates the setting in which the Works Program has operated. Other sections deal with various aspects of the Program: work accomplished, employment provided, projects prosecuted, expenditures, and the nature of the activities of participating agencies. Detailed statistics presented in the appendix supplement the body of the report.

Tabulations of physical accomplishments on WPA projects in each state and the United States from the beginning of the program through September 15, 1936, have been released. The information is limited to certain types of activities and measures work which has been actually completed as of the above date. A revised report form is being developed with the aim of obtaining another inventory of physical accomplishments in the near future.

A general bulletin on trends in WPA employment from the inception of the program through December, 1936, will be issued shortly, and will include for the United States and the individual states data on WPA employment, earnings, man-hours, and average hourly earnings, by months. Data on persons employed will represent the number of different persons employed at any time during the month.

Two bulletins presenting the results of special studies of WPA employment in June, 1936, are in preparation. Entitled, respectively *Age of Persons From Relief Rolls Employed on WPA Projects in June, 1936*, and *Employment and Wages on WPA Projects in June, 1936*, these releases will be composed largely of statistical material, but will also contain brief textual summaries and descriptions of the data.

Plans are in process for a survey of Works Program labor turnover based on existing records maintained in the various field offices of the WPA. The study proposes the collection, tabulation, and analysis of information such as (a) rates of separations and accessions of the Works Program, (b) continuity and duration of employment on the Works Program, and (c) influence of geographic location, age, sex, family composition, and other pertinent factors upon separation and accession rates and upon continuity and duration of Works Program employment. The investigation is intended to reveal the total number of different persons employed during the course of the Works Program in the areas covered by the study, the number of persons and families dependent upon Works Program at one time or another, and the average period of employment provided. It is planned to limit the initial survey to one state and four cities, in order to perfect the details of the survey preparatory to later extension on a national scale.

An analysis of unemployment data is being made to determine methods of estimating the number of *families* with no employed member. Unemployment estimates and census material purport to give the number of persons out of work. Since the unemployed from one-worker and multi-worker families are all included, the current estimates of unemployment give no clue as to the number of families with no employed persons. This latter information is of special significance from the relief standpoint and methods of deriving this information are being investigated.

The Labor Research Section has completed a report based on a field investigation of the skills of brick and stone masons, carpenters, and painters employed on WPA projects in seven cities. The examination of skills was made independently by representatives of the international trade unions concerned and by representatives of the Works Progress Administration. The investigation which was carried on in January, 1937, indicates that in the seven cities covered the workers studied were generally performing their duties in a highly efficient manner; only 9.0 per cent of all the workers having been judged to be definitely inferior in the quality of their work by both examiners and only 7.6 per cent having been so graded by both examiners with respect to the quantity of the work they were capable of doing.

Relief Statistics. A classification of total expenditures of the Emergency Work Relief Program has now been completed for a number of states. This program was conducted as a part of the general relief program by state and local relief administrations with the aid of funds made available by the Federal Emergency Relief Administration. The tabulations cover the entire program which began when the Civil Works Program was terminated and was discontinued shortly after the Federal Works Program was or-

ganized in the summer of 1935. The tabulations classify total expenditures by type of project, by object of expenditure and by source of funds. Tabulations are being published for individual states as they are completed. They are based on optional reports submitted by State Emergency Relief Administrations.

Bulletins on *General Relief Statistics* presenting the total number of families, cases and persons and amounts of obligations incurred for states submitting adequate data and estimated totals for the Continental United States have continued to be published monthly. Preliminary data for urban areas on the number of cases and amounts of relief extended have also been published several weeks in advance of the state and national totals. Both publications have been prepared by the staff of the Advisory Committee on the Collection of General Relief Statistics which functions through the cooperation of the Social Security Board.

Advisory Committee on the Collection of General Relief Statistics. The Advisory Committee on the Collection of General Relief Statistics and the joint technical staff which were established on September 30, 1936, by the Works Progress Administration and the Social Security Board, continued through March 30, 1937, with the work of obtaining, compiling and analyzing for publication reports of general relief activities. At the latter date, reports for each state, either on a complete and adequate basis, or covering a substantial part of the case load and obligations incurred for relief extended, were being obtained from relief or welfare departments in all states but Mississippi.

In addition to this work, other activities of general interest of the joint staff, since the first of the year, were the preparation of a report based on a nation-wide survey of the relief aspects of the distribution of surplus commodities and the preparation of a bulletin entitled "Summary of Recent Statistics of Relief in the United States."

The survey of the distribution of surplus commodities is now in preliminary draft and will be published in final form in the near future. The conclusions in this report are drawn from replies to approximately 250 questionnaires sent to state officials connected with the administration of general relief or special types of assistance and the local relief officials in both urban and rural communities. State Directors of Commodity Distribution also submitted replies to the questionnaire. The individuals from whom comment was invited were carefully selected from the standpoint of their familiarity with the relief problem in their respective states or localities.

The "Summary of Recent Statistics of Relief in the United States" was prepared by Thomas B. Rhodes, Secretary of the Advisory Committee, at the request of Walter West, Executive Secretary of the American Association of Social Workers, and was distributed to delegates to the 1937 conference of the Association. This pamphlet reviews the available statistics pertaining to relief operations of the Division of Public Assistance of the Social Security Board, the Works Progress Administration, the Resettlement Administration, and state and local governments. A limited supply

of this pamphlet is available at the office of the American Association of Social Workers at 130 East 22nd Street, New York City.

NATIONAL RESEARCH PROJECT, WORKS PROGRESS ADMINISTRATION.—The several studies undertaken by this Project have been briefly described in other numbers of the JOURNAL. In the March issue it was reported that the work of collecting materials was almost completed. At the present time (April 15) tabulation and analysis are well advanced and reports are in preparation.

A general discussion of the problem of "Unemployment and Increasing Productivity" has recently been issued. This report, based on published materials, was prepared as a chapter in a forthcoming publication of the National Resources Committee entitled, *Technological Trends and Their Social Implications.*

Statistical Studies of Changing Productivity. A forthcoming series of reports will deal with labor productivity in a number of industries. These studies are based primarily on published data.

Special Studies of Selected Industries. Analytical work is proceeding on each of the studies of manufacturing industries, extractive industries, agriculture and railroad transportation.

A survey of "Technology and the Mineral Industries" is now being reproduced for distribution. This report also was prepared for the National Resources Committee's symposium and is based in part on data collected under a cooperative arrangement between the Project and the U. S. Bureau of Mines. A report on small scale placer gold mining will soon be ready for release.

The studies in agriculture will present data on changes in production, employment, farm practices, and machinery and equipment utilized by crops and crop areas. Several monographs will be available in the near future.

Surveys of the Effects of Industrial Changes on Labor Markets and on Individual Workers. Tabulation and analytical work are progressing on each of the labor market surveys, and reports are now in preparation. An analysis of employment and unemployment in Philadelphia in the Spring of 1936 will soon be ready for release.

Special tabulations on work and wages at the Amoskeag Manufacturing Company's textile mills during 1927–35 were prepared in cooperation with the Social Security Board for use in connection with the Tripartite Technical Conference of the International Labour Organization in Washington.

DIVISION OF SOCIAL RESEARCH, WORKS PROGRESS ADMINISTRATION.—*Areas of Minor Civil Divisions.* With the cooperation of local agencies in the states, the Rural Section has computed, or checked, the areas of townships and other civil divisions smaller than counties. The data compiled will include, by state, county, and minor civil division, the land area in square miles and acres, the number of acres in farms and percentage of total area, the total population and population density per square mile.

Areas have been computed by planimeter calculations from Bureau of the Census maps of states with minor civil division boundaries. Land in farms and population figures have been taken from the 1930 Census. There will be no general distribution of the results, but a limited number of copies will be available on request for research workers concerned with population problems and related fields.

Study of Youth Applying for Positions and Placed by U.S.E.S. A study of the extent to which the United States Employment Service reaches rural and urban youth is being planned. The general plan involves securing data, from both industrial and rural counties, on active registrants with the Employment Service as of April 1, 1937. Information on placements will be taken for July, 1934, January, 1935, July, 1935, January, 1936, July, 1936, and January, 1937.

Rate of Replacement of Males in the Rural-farm Population. Rates of replacement of males 18–65 years of age in the rural-farm population from 1930 to 1955 have been computed for the United States. Similar data on a state basis are available for the period 1920 to 1935.

The following recent publications of this Division represent the findings of a variety of studies which were completed during the past year: *Chronology of the Federal Emergency Relief Administration*—Research Monograph VI; *The Migratory-Casual Worker*—Research Monograph VII; *Farmers on Relief and Rehabilitation*—Research Monograph VIII; *Survey of the Transient and Homeless Population in 12 Cities, September 1935 and September 1936*—Research Bulletin, TR-12; *Areas of Intense Drought Distress, 1930–1936*—Research Bulletin, Series V, No. 1; *The People of the Drought States*—Research Bulletin, Series V, No. 2; *Relief and Rehabilitation in the Drought Area*—Research Bulletin, Series V, No. 3; *Natural and Economic Factors Affecting Rehabilitation in the Upper South Plains of the Texas Panhandle and the High Plains of Eastern New Mexico*—Research Bulletin, K-10; *The Agricultural Situation in the Intensive Livestock Production Area of Southeastern South Dakota*—Research Bulletin, K-11; *Natural and Economic Factors Affecting Rural Rehabilitation on the South Plains of the Texas Panhandle*—Research Bulletin, K-12; *Natural and Economic Factors Affecting Rural Rehabilitation in Southeastern Wyoming*—Research Bulletin, K-13, and *Current Statistics of Relief in Rural and Town Areas, November-December and for the Year 1936; December 1936–January 1937 and for the Years 1932–1936; January–February 1937 and for the Years 1932–1936.*

The results of other completed surveys are now in press or in manuscript form.

CHILDREN'S BUREAU, U. S. DEPARTMENT OF LABOR.—*Consolidation of Statistical Services of the Children's Bureau.* Consolidation of three statistical services of the Children's Bureau in a Division of Statistical Research has just been effected. The Director of the Division is Robert J. Myers, of Chicago, formerly director of research and chief statistician of the Illinois Emergency Relief Commission and later of the Illinois Works Progress

Administration. Dr. Elizabeth C. Tandy, of the general statistical division of the Children's Bureau, will be Assistant Director of the new Division. The statistical activities consolidated in the new Division of Statistical Research include those of the general statistical division, the social statistics unit, and the statistical unit of the Division of Research in Child Development.

The general statistical work of the Division includes the planning, tabulating, and analyzing of statistical studies undertaken in connection with the programs of other divisions, and the collection and tabulation of current statistical reports from state and local officials in charge of issuance of employment certificates to children and from juvenile courts handling delinquency and dependency cases.

The work of the social statistics unit of the division will be in charge of Miss Frances M. Welch. This unit, which had its origin in 1930, handles reports from agencies in the group of cities cooperating in reports on local public and private social services in twenty-one fields concerned with or relating to child welfare.

The statistical work on child growth and development will be in charge of Dr. Rachel M. Jenss. These studies of a highly scientific character are undertaken in connection with the programs of the Division of Research in Child Development.

Industrial Home Work Under the National Recovery Administration. A report on industrial home work under the National Recovery Administration setting forth the findings of a study undertaken at the request of the NRA has just been published by the Children's Bureau of the U. S. Department of Labor. The field work for this study was carried on jointly by the Women's Bureau and the Industrial Division of the Children's Bureau. The purpose of the study was to make available to the home work committee of the NRA information regarding conditions under which home work was being carried on in industries in which it had not been abolished by the codes.

The report contains a discussion of industrial home work in general; the scope and purpose of the study; attempts at legal regulation; development of home-work provisions of the codes; home-work operations and conditions of work; and possibilities of adjustment of home workers to factory employment. Specific industries in which industrial home work was studied included the knitted-outerwear industry, the lace industry, infants' and children's wear industry, art-needlework industry, fresh-water pearl button industry, doll and doll-accessory industry, tag industry, and leather glove industry.

The conclusions drawn from this study indicate that attempts to regulate industrial home work through State laws have proved ineffective, and that a number of manufacturers who had brought their home workers into the factory in compliance with provisions of the codes stated that the difficulties of adjustment had not been so great as was anticipated and that the advantages of having the worker on the premises were many. Under the NRA

great gains were made where the codes prohibited giving out home work, but in industries in which home work was still permitted, even though limited by certain regulations, the ancient evils continued to exist, constituting a menace to the higher labor standards achieved for factory workers. The great majority of the chief home workers included in this study earned less than a living wage. Fifty-five per cent made less than 10 cents an hour; 82 per cent earned less than 20 cents. Only 5 per cent of the workers reporting hourly earnings made as much as the usual code minimum of 35 cents an hour.

Trends in Different Types of Public and Private Relief in Urban Areas, 1929–35. Under the above title the Children's Bureau has published a summary of available data on trends in relief expenditures and cases in the reporting area from the beginning of 1929 through 1935. The nucleus in the Bureau's collection of relief statistics was a monthly reporting project covering various fields of social and health work in a representative group of cities with 50,000 or more population, for which the Bureau assumed responsibility in July 1930 following a period of experimental development by the local community research committee of the University of Chicago in cooperation with the Association of Community Chests and Councils.

In October 1930 the President's Emergency Committee for Employment requested the Children's Bureau to extend its collection of relief reports to include all cities of 50,000 or more population. The Russell Sage Foundation cooperated by making the data on relief expenditures and cases that had been assembled in its project available for the areas not included in the Bureau's project for the registration of social statistics. In 1932 arrangements were made with the Russell Sage Foundation for transferring to the Children's Bureau the responsibility for the collection of monthly relief reports from these cities. From that time the series covered 120 urban areas.

In accordance with the policies formulated by the Children's Bureau's Advisory Committee on Social Statistics and following the recommendations of the various Federal agencies especially concerned with relief statistics, responsibility for the continuation and publication of the monthly relief series for 120 urban areas was transferred to the Social Security Board as of July 1, 1936.

This report was written by Emma A. Winslow, Ph.D., of the Children's Bureau staff who was in charge of the monthly relief statistics until this work was transferred to the Social Security Board. It is a record of the increased needs for relief during the period of the depression and of changes in the methods used in financing and administration. In presenting the trends for the 7-year period special analysis was made of regional variations in the number of cases aided through different types of public and private relief and in the average monthly relief per case. The report contains 143 pages and includes a discussion of trends and tables showing annual and monthly expenditure for different types of relief and numbers of cases receiving aid.

New Studies Undertaken by the Children's Bureau include: (1) A study of adoption records of state departments of public welfare to determine the

effectiveness of state programs for safeguarding the interests of children in adoption proceedings. This study is being conducted in ten states which have authorized social investigations of adoption petitions referred by the courts.

(2) A study of children born out of wedlock, to evaluate the results of the Maryland law which prohibits the separation of a child under six months of age from his mother, except under certain conditions. Data will be obtained as to children born out of wedlock during 1935 in Baltimore to discover the extent to which social agencies have cooperated with the mothers, and some follow-up will be made of cases in which there had been no agency contact. Court records will be consulted for information as to the children who have been adopted or whose paternity has been established through court action.

(3) A study of fetal neonatal and maternal deaths in the District of Columbia which is being made in cooperation with the Department of Health, the Committee on Maternal Care of the District Medical Society, and a number of hospitals which have permitted access to their records.

(4) A study of premature infants, in cooperation with the obstetric and pediatric departments of the Johns Hopkins Hospital, covering all premature infants born in that hospital during the period of the study. A follow-up clinic for all these prematurely born infants has been developed. Through this study it is hoped (a) to determine the value of various types of treatment of prematurely born infants, in order to reduce the high mortality rate of these infants; (b) to work out various problems in relation to growth in the fetal and neonatal periods.

WOMEN'S BUREAU, U. S. DEPARTMENT OF LABOR.—"Women's employment in West Virginia," shortly to come from the press as *Women's Bureau Bulletin 150*, analyzes the pay-roll data for more than 14,000 women in factories, stores, laundries and dry cleaners, hotels and restaurants, in West Virginia in the summer of 1936. Besides current figures, pay rolls for 1935 were made available by 75 of the 199 establishments, so that changes after the NRA codes were no longer in effect would appear. In general, week's earrings were higher in 1936, but hourly earnings, because of an increase in working hours, had declined.

Bulletin 151, "Injuries to women in personal service occupations in Ohio," is based on unpublished figures in 1932 and 1933, for both sexes, made available to the Bureau by the Department of Industrial Relations of Ohio. The lines of employment covered are laundries and dry-cleaning plants, hotels, restaurants, beauty and barber shops, and households. The coverage of the last two probably is limited, as the compensation law is compulsory only in the case of employers of three or more persons. Besides the unusual inclusion of household employees, the figures are exceptional in showing the numbers of all injuries instead of only those that involved loss of time. This feature is important in the study of cause and prevention. The data give cause,

location, nature, and severity of the injuries, and age, occupation, wages, and number of dependents of the injured.

The Bureau has made a number of surveys to obtain wage data for the use of the Division of Public Contracts administering the Walsh-Healey Act.

OFFICE OF EDUCATION.—*Statistics of State School Systems.* Continuing the work of reorganizing the Statistics of State School Systems for the 1937–38 collection, five regional conferences were held in March and April with the directors of research and statisticians of from seven to twelve state departments of education at Washington, D. C.; Springfield, Illinois; Salt Lake City, Utah; Montgomery, Alabama; and Hartford, Connecticut. Around a table, for four or five days each, these groups discussed definitions and certain desirable blocks of information that should be a part of a national reporting system and considered what data they could supply for 1937–38.

Library Statistics. Mr. William H. Clift, Statistical Assistant, American Library Association, has been loaned to the Office of Education for three months to set up forms for the collection of statistics of public, school, and college libraries as the first project in the new division of library service.

University Research Project. This program has probably been unparalleled in the scope of cooperative endeavor of large universities in educational research. While not a WPA project, it was financed under the Emergency Relief Administration Act of 1935 and set up according to national, state, and district WPA regulations to use persons on relief who were qualified to do research work. The project was under the general direction of the Office of Education with Benjamin W. Frazier, Senior Specialist in Teacher Training of the Division of Higher Education, as the Director.

Sixty universities and comparable institutions located in 32 states, the District of Columbia, and Hawaii, participated actively in the project during most of the year 1936. The complete list of institutions qualifying for work in the project is given in *School Life* for May, 1936.

Twenty-three members of the regular staff of the Office of Education served as study coordinators of 40 studies. Twenty-three of these studies were proposed by the Office of Education and 17 by cooperating universities. The institutions completed from 1 to 14 studies each, making more than 150 reports on studies. Each project was conducted by from 1 to 31 institutions and all the cooperative research was completed early in 1937. In January, 1937, specialists in the Office of Education who served as study coordinators began the task of assembling and coordinating institutional findings, and of preparing consolidated study reports for the printer. Publication plans call for the printing of many of the major study reports in a series of Office of Education bulletins. All manuscripts will have been sent to the United States Government Printing Office by June 30, 1937.

Some of the more popular project studies undertaken are:—Study No. 7. Economic study of college alumni conducted in 31 institutions, covering

75,000 alumni; Study No. 10. Student mortality in institutions of higher education conducted in 25 institutions, covering 15,000 freshmen; Study No. 14. Relation between certain factors in high school education and success in college, conducted by 17 institutions; Study No. 5. Economic status of rural teachers.

NATIONAL RESOURCES COMMITTEE.—*Public Works.* The National Resources Committee's Report "Public Works Planning" was transmitted to Congress by President Roosevelt on February 3, 1937. This Report includes recommendations for planning, programming, timing, and division of costs of public works, as well as a summary report on drainage basin problems and programs. The Report was prepared by two groups under the National Resources Committee, a special research staff, and by the Water Resources Committee, both working in collaboration with the Projects Division of the Public Works Administration.

Water Resources. On April 12, 1937, the full "Drainage Basin Problems and Programs Report" was released. The report covers in further detail the water problems and programs for 118 drainage basins, and includes maps and project lists. It was prepared by the Water Resources Committee of the National Resources Committee.

On April 7, 1937, the National Resources Committee released its Second Report on Water Pollution. The report reviews the progress made in the treatment of wastes during the past three years and contains statistics on sewage treatment. It also makes recommendations regarding legal, administrative and financial aspects of the water pollution problem. The report was prepared by the Special Advisory Committee on Water Pollution of the Water Resources Committee.

Population Study. The Committee on Population Problems of the National Resources Committee has completed its report to be published under the title of *The Problems of a Changing Population*, Government Printing Office (75¢, paper) and *Statistical Supplement* (30¢, paper). The Committee has also prepared a manual on population studies for the use of State Planning Boards.

NATIONAL INDUSTRIAL CONFERENCE BOARD.—In the field of National Income, to which the Board is giving special attention, perhaps the most important of its recent publications is a statement of national income realized by Dr. Robert F. Martin which covers the entire period from 1909 to 1935. It gives not only an estimate of total income but a classification by source of income and by type of income. Mr. John A. Slaughter has made a study of "Income in Bituminous Coal Mining (1929–1936)" and has presented the first results of an investigation of income by states (1929–1935). The latter publication anticipates the issue of a larger volume on "Income by States," which is in the printer's hands. This volume will show not only the total income of each state but a distribution of this income by industrial source and also by type of income.

The Board's studies in the field of Unemployment bore fruit in a study of "Unemployment and Business Recovery" which has attracted wide attention. Under an assumption of unchanged hours of work and a continued increase of output per man-hour, the conclusion was reached that the year 1940 would see a labor shortage.

The Board's monthly studies of changes in the cost of living were recently summarized for the year 1936 in a special publication. A similar study was made of the "Adjustment of Wages According to Changes in the Cost of Living."

The following studies are under way: cost of government in the United States, 1934–36, sales and chain store taxes, dismissal compensation, economic situation of Germany, the labor force in the United States, and further unemployment estimates. For the Chemical Alliance the Board is undertaking an extensive survey of labor conditions in the chemical industry.

THE RESEARCH BUREAU, WELFARE COUNCIL OF NEW YORK CITY.—Preliminary findings of the Welfare Council's Youth Survey are being presented in *Better Times*, the weekly review published by the Welfare Council. The Survey has been conducted with the assistance of the WPA and at the request of welfare organizations dealing in one way or another with the problems of the City's youth. It is unique in that it is the only city-wide census or sample survey conducted in New York City in which information was obtained regarding the religious affiliation of the population, or a segment thereof. The Survey was conducted by visiting each hundredth residential address recorded on a previous complete survey undertaken for a different purpose and interviewing every person within specified ages found living at the selected addresses who could be located and who was able and willing to give the information desired. This procedure insured so far as possible a genuine representation of all social and economic, racial and cultural groups in the sample of 9,041 young men and women between 16 and 24 years of age. The inquiry as to religious affiliation was in terms of the religious community with which the young person felt himself to belong or which he felt best represented his religio-cultural background. In this sense, 49 per cent of the interviewed youth reported themselves as Roman Catholic, 31 per cent Jewish, and 18 per cent as Protestant. Only one half of one per cent disclaimed any connection with any religious group. The entire sample follows closely the color and nationality of the population of like ages in New York City as shown by the 1930 Census.

AMERICAN STANDARDS ASSOCIATION.—The Standards Council has approved a revised "American Standard for Compiling Industrial Injury Rates." The new Standard recognizes temporary partial disabilities as a distinct class and substitutes lost time for disability as a criterion for compiling accident statistics. It is expected that the Standard will be published soon.

Insurance companies, state accident commissions, labor departments, outstanding trade associations and the Federal Government have all cooperated

in the development of this Standard. Mr. Leonard W. Hatch of the International Association of Industrial Accident Boards and Commissions, and formerly of the New York State Industrial Board has served as Chairman of the Committee which developed the new Standard.

POPULATION ASSOCIATION OF AMERICA.—The Fourth General Assembly of the International Union for the Scientific Investigation of Population Problems will meet in Paris on July 28th in connection with the International Population Congress, organized by the French National Committee, which takes place on July 29 to August 1. The Population Association of America, through its Research Committee, which is also the American National Committee of the International Union, is sending a number of delegates to attend the Assembly and the Congress. The delegates appointed, together with the papers which they will present at the Congress, are as follows:

O. E. Baker, "Some Agricultural Implications of the Population Prospect in the United States."

Joseph V. DePorte, "Fusion of the Racial Elements of the American People as Observed in the State of New York."

Harold F. Dorn, "The Relative Amount of Ill Health in Rural and Urban Communities."

Louis I. Dublin, "Life Tables for the Native and Foreign-born Population of the United States, Separately for Rural and Urban Areas."

H. P. Fairchild, No paper.

Carter Goodrich, Subject of paper to be announced later.

Norman E. Himes, "Some Universal Principles on Fertility Control in Man."

Clyde V. Kiser, "Differential Marriage Rates According to Social Class of Parents for Families Enumerated in Three American Cities."

C. E. Lively, "The Development of Research in Rural Migration in the United States."

Frank A. Lorimer, "Distribution of Population in Relation to Economic Resources in the United States."

Alfred J. Lotka, "Some Recent Results in Population Analysis."

Frank W. Notestein, "A Demographic Study of 38,256 Rural Families in China, Based on a Field Study of Selected Communities."

Frederick Osborn, "The Application of Measures of Quality."

Raymond Pearl, "Economic Status, Fertility, and Contraception as Observed in the Populations of Large Cities in the United States."

Frederick F. Stephan, No paper.

S. A. Stouffer, No paper.

Warren S. Thompson, "An Experiment in the Registration of Vital Statistics in China."

Leon E. Truesdell, Subject of paper to be announced later.

P. K. Whelpton, No paper.

Robert M. Woodbury, Subject of paper to be announced later.

T. J. Woofter, Jr., "Rural Population Pressure in the United States and Governmental Policies during the Depression."

Adequate representation of American scholars on this occasion has been made possible by a grant of $2,500 from the Milbank Memorial Fund and a grant of equal amount from the Carnegie Corporation of New York, towards the expenses of the delegation.

THE PSYCHOMETRIC SOCIETY.—The mid-western district meeting of the Psychometric Society was held April 3, 1937, at the University of Chicago. The program was devoted to the mathematics of learning, statistics and test theory, and to factor analysis. Dr. N. Rashevsky of the University of Chicago addressed the Society at the dinner meeting on "Physico-Mathematical Methods in Psychology."

The annual meeting of the Psychometric Society will be held at the University of Minnesota, September 1, 2, 3 and 4 in conjunction with the meetings of the American Psychological Association.

The journal, *Psychometrika*, official organ of the Psychometric Society, has completed its initial year, and No. 1 of the second volume is now off the press.

AMERICAN ASSOCIATION OF UNIVERSITY TEACHERS OF INSURANCE.—The *Proceedings* of the 1936 Annual Meeting of the Association held in Chicago December 28, 1936, have been printed and copies are available from the Secretary, Professor Frank G. Dickinson, University of Illinois, Urbana, Illinois, at $1.50 per copy. This is the first appearance of printed proceedings, although mimeographed editions of the annual meeting papers and discussions have been issued for the first three annual meetings.

CHAPTER ACTIVITIES

THE AUSTIN CHAPTER.—Mr. V. C. Childs of the Division of Crop and Livestock Estimates, United States Department of Agriculture, spoke to the Austin Chapter at a meeting on February 25, 1937. He outlined the work of the Division of Crop and Livestock Estimates, explaining the method of obtaining data for the various current releases of the Division and for long range studies being undertaken. Twenty-six members were present.

At a meeting on March 18, 1937, with seventeen members present, the speaker was Mr. G. D. Clark of the United States Department of Agriculture. Mr. Clark, who had just returned from Cuba where he was in charge of a survey of the fruit and vegetable industry of Cuba, gave a report on this survey. The survey was undertaken by the United States Department of Agriculture at the request of the Cuban Government. The principal crop involved was tomatoes, which the Republic of Cuba ships principally to the New York market. For a part of the season the Cuban crop competes with the Florida crop. Mr. Clark stated that the Cuban Government maintained a rigid control over the exports to prevent any "dumping" of the Cuban crop.

THE CHICAGO CHAPTER.—At a meeting on February 23, attended by 29 members, Mr. Gerald K. Thorne of Wilson and Company spoke upon the "Development and Use of Agricultural Statistics." On March 24, Mr. W. B. Ricketts, Manager of the Market Surveys Division of Booz-Fry-Allen and Hamilton, addressed 53 members and guests on the subject, "Measuring the Effectiveness of Advertising."

The annual meeting of the Chicago Chapter was held April 28. Speakers were Nat C. Murray, Crop Statistician, Clement Curtis and Company, and Edward N. Wentworth, Director of Armour's Livestock Bureau. Mr. Murray's subject was "Agriculture in Argentina" and Mr. Wentworth spoke on the "Development of the International Meat Trade." Membership of the Chapter, at the last meeting of the year 1935–36, totalled 128 as compared with 107 for the prior year.

THE CLEVELAND CHAPTER.—The fifth meeting for the present season of the Business Statistics Section of the Chapter was held on February 15 at the Mid-Day Club. The speaker was Mr. Howard Whipple Green of the Cleveland Health Council. Mr. Green's address concerned the relief and unemployment situation in Cuyahoga County.

At the sixth meeting, Mr. Russell Weisman, columnist for the Cleveland *Plain Dealer*, discussed the recent statement of Marriner S. Eccles, Chairman of the Board of Governors of the Federal Reserve System, concerning methods to guard against inflation. An interesting question and answer period followed. There were twenty-five members and guests present at both meetings.

THE CONNECTICUT CHAPTER.—The Chapter held a joint annual and business meeting on January 28, 1937, in New Haven. The speaker at this meeting was Professor Kossuth M. Williamson of Wesleyan University and his subject was "Some Aspects of Business Taxation."

The following officers were elected for 1937: President, Dr. John H. Watkins, Assistant Professor of Public Health, Yale University; Vice-President, Mr. Morgan Mooney, State Bureau of Labor, Hartford, Connecticut; Secretary, Mr. Louis M. Nichols; Executive Committee, Mr. Lawrence G. Flick and Mr. Paul Dorweiler.

The Chapter met on Monday, March 8, 1937, at the University Club, Hartford, Connecticut. The subject discussed at this meeting was "Research and Statistical Phases of the State Reorganization Plan" and the speaker was Dr. Benjamin P. Whitaker, Research Director of the Commission.

THE NEW YORK DISTRICT CHAPTER.—On January 26 the Chapter held a dinner at which attendance approximated 500. The general subject was "The Outlook for Security Prices." The speakers were as follows: Mr. James F. Hughes of C. D. Barney and Company, members of the New York Stock Exchange, Mr. C. J. Collins, Chairman of the Board of Investment Counsel, Incorporated, Detroit, Michigan, Mr. A. W. Kimber of White, Weld and Company, members of the New York Stock Exchange, and Mr. H. M. Gartley of H. M. Gartley and Company, Incorporated, New York City.

Mr. Hughes, speaking on "The Outlook for Stock Prices," described it as more uncertain than during 1935 and 1936, although the favorable fundamental background was unchanged. The technical probabilities are not encouraging since during the last 50 years the market has never had three good years in a row. The financial factor is fundamentally bullish, but includes the uncertainty of a possible important curtailment in the rate of bank credit expansion during 1937. There is no certainty that a further increase of five to ten per cent in general business activity would be reflected in substantial advances of the stock market, especially since such an increase would lift business activity beyond the statistical normal level. Governmental action to control credit and speculation can be expected in 1937, yet it is still uncertain whether such action will be effective in holding the market down. A number of measures have been discussed and at least some of them might well have a serious, although temporary, effect on the market.

Mr. Collins pointed out that the 1932 deflation had caused credit to become redundant and had reduced raw material prices in many instances below production costs. The Lausanne settlement of the pressing war debt problem provided the psychological background necessary to start an upward trend. These basic factors may still be described as favorable. The primary trend points upward for several years to come although it can be subjected to disturbing intermediate interruptions. The conditions which promoted credit expansion in 1935 and 1936 may be materially altered by governmental action. Other factors that may produce intermediate declines

are labor troubles, rising business costs, possible overexpansion of inventories, increased taxation, renewed foreign exchange uncertainties in Great Britain and Japan, and the record length and extent of the present intermediate advance. Looking ahead to the next decade, the largest economic question which business and the market must face is whether the inflationary forces largely developed by the political conduct of the past several years can be controlled.

Mr. Kimber discussed "The Railroad Outlook for 1937." The statistical record for recent years has led many to believe that rail transportation is a declining industry. In the peak year, 1926, the Class I railroads carried 440,000,000 ton miles of revenue freight, received operating revenues of $6,383,000,000 and reported net income after charges of $809,000,000. In 1932 the tonnage and revenues had been halved. In 1936 the total ton miles were still about 25 per cent and the operating revenues about 37 per cent below 1926. As a result nearly 30 per cent of the Class I mileage is in receivership and about $2,500,000,000 of obligations are in default. This slump was due in part to competition from other transportation agencies. Motor carriers had been the most damaging competitors. However, some of the freight lost to trucks was unprofitable to the railroads and at least 70 per cent of the ton miles of freight consists of bulk commodities, heavy manufactures and other goods which are unlikely to move by truck. Railroad transportation is a mass production, low cost business and seems unlikely to suffer much further from the competition of waterway, pipe lines or truck. Other important reasons for the slump in railroad earnings are the drought in the western states, government crop restriction, and the lagging recovery of the production of capital goods. These factors may be less serious in the future. The elimination of emergency surcharges and the possibility of wage increases are unfavorable factors but a traffic increase of about 10 per cent would offset the losses that may be expected from these sources.

Mr. Gartley pointed out that advances in the price of common stocks comparable to those which occurred during 1935 and 1936 could hardly be expected, but that there was some room for further improvement in share prices. He indicated further that whatever direction these prices take the market will be even more selective than in 1935 and 1936. He pointed out that several developments have operated to reduce the floating supply of shares and to place them in stronger hands. He also pointed out that stock exchange regulation will place a ceiling over extravagant price movements by the employment of some or all of at least ten distinct means available to the Securities Exchange Commission. At the same time he remarked that so far regulation had seemed to produce little change in the character of price movements. Mr. Gartley closed his discussion by pointing out certain minor groups which in his opinion are likely to be outstanding in 1937.

THE PHILADELPHIA CHAPTER.—The Philadelphia Chapter met on March 5, 1937, to discuss "Commodity Prices." Mr. Robert D. Gray of the Industrial

Research Department, University of Pennsylvania, discussed the work of the International Scientific Committee on Price History and the results which have been secured in the study of wholesale prices in Philadelphia from 1720 to 1861.

The International Scientific Committee on Price History was organized in 1929 through the efforts of Professor Edwin F. Gay and Sir William Beveridge. Through funds received from The Rockefeller Foundation, the Committee has coordinated and encouraged studies of prices in England, France, Germany, Austria, Spain, Holland, Poland, and in several areas of the United States: Boston, New York, Philadelphia, Charleston, S. C., New Orleans, and Cincinnati. Twenty-five volumes, in addition to many articles, have already been published or are in manuscript form.

While the primary purpose of the Committee was to increase the amount of factual data relating to previous fluctuations in prices and wages by securing continuous series, it has been interested in applying modern statistical techniques to the analysis of history. How severe, how frequent, and how widespread were the previous fluctuations in prices are some of the questions which the Committee considered. The supplying of continuous series of prices will permit further studies to be made by other students.

Mr. Gray discussed the methods used by the price-study group of the Industrial Research Department of the University of Pennsylvania in collecting wholesale prices reported by the newspapers and in checking the validity of these prices as well as filling in gaps in the newspaper files by using prices quoted in merchants' letters and account books. He also selected three conclusions reached by the Philadelphia group which are of special significance in current studies of fluctuations in prices:

1. Disregarding the Revolutionary War period, there were twenty-five complete cycles in prices from 1731 to 1861. Detailed statistical measurements of the length and severity of these cycles showed that there was no persistent tendency for the movements of prices to become more or less severe or longer or shorter during these years in which Philadelphia was influenced by the beginning of a change from an agricultural to an industrial community.

2. The study in Philadelphia of prices during the century and a quarter preceding the Civil War illustrates the difficulties involved in determining whether or not prices of one group of commodities are out-of-line with prices of another group. Although similar cycles in prices occurred in most series, there was no year in which the price of every commodity was higher or lower than it had been in the previous year. The study also emphasized the fact that agricultural prices have always fluctuated more violently than prices of industrial goods.

3. An examination of the number of times that quotations changed each year showed that so-called "administered prices" have always been characteristic of certain commodities. It was found that the prices of some commodities tended to become more sensitive as facilities for transportation and communication improved. Other commodities changed in price very infre-

quently and even tended to become insensitive. Some of these changes can be attributed to the growing obsolescence of such commodities and the consequent change in their relative economic importance.

Mr. Waldo E. Fisher, Assistant Professor of Industry, Director of the Coal Section, Industrial Research Department, University of Pennsylvania, discussed prices in the bituminous coal industry. The Committee on Prices in the Bituminous Coal Industry is one of five committees appointed by the Conference on Price Research. These committees have been instructed to make exploratory studies in their respective industries and to suggest programs of research. The Bituminous Coal Committee was appointed in September, 1936. The objectives as approved by the Committee are as follows: (1) To state clearly the scope and operating characteristics of the industry which influence price levels and price problems in this industry; (2) to ascertain what price and related data are being currently collected for this industry; (3) to appraise these data and to make recommendations as to how the factual record of the bituminous coal industry may be made more useful to the industry, the government, economists, and the public; (4) to suggest those phases of the problems of prices which are in need of further study and research and which are of greatest significance to the industry, economists, and the public; and (5) to consider the steps which might be taken to promote and more effectively coordinate research in price and related problems in the bituminous coal industry.

The Committee has made a careful survey of the price data being currently collected for this industry. It is also working with the Bureau of Labor Statistics and assisting it in its revision of both the wholesale and retail price series which the Bureau is collecting for the industry. The Committee is now engaged in preparing a coordinated program of research in bituminous coal.

Mr. Stephen J. Kennedy, Director Research of the Pacific Mills, New York City, discussed prices in the textile industries. Effective research into the behavior of textile prices can contribute importantly to the analysis of problems confronting the textile industry. These problems include among others such important phases of textile marketing management as determining the effects of manufacturers' price changes upon consumer demand at various stages of the business cycle, and conversely the effects of retail price brackets upon manufacturers' prices. Before effective work can be done along these lines, however, more progress will need to be made in improving basic textile price data. Important and far-reaching steps pointing in this direction are already being undertaken by the Bureau of Labor Statistics, both in the wholesale and retail fields. All possible encouragement to the continuance and extension of this work should be given by every statistician interested in price analysis.

Investigation in this field will also be greatly aided if account is taken of the interrelationships of textile prices on the various levels of manufacture. The Committee for the Study of Price Research in Textiles, which has been

conducting a survey of existing textile price data with a view to making possible further studies in this field, has given a great deal of attention to improving the classification of textile statistical data. This classification which has been worked out is based upon a flow of goods concept from the raw material through the various stages of manufacture to the retail market. Analysis of the behavior of prices in the markets at each stage of manufacture seems to appear to be the most promising line of investigation of textile price behavior. Comprehensive analysis along this line should throw important light upon many problems of interest both to the industry and to economists.

The Chapter met on April 9 to discuss "Statistical Studies of Cost of Living, Dependency and Relief, and Crime and the Depression."

Miss Alice C. Hanson, Assistant Chief, Cost of Living Division, U. S. Bureau of Labor Statistics, spoke on "Family Expenditures of Employed Wage-Earners and Clerical Workers in Philadelphia." Of the 55 cities in which studies of money disbursements of employed wage-earners and lower-salaried clerical workers have been made by the United States Bureau of Labor Statistics since the fall of 1934, five are Pennsylvania cities: Philadelphia, Pittsburgh, Scranton, Johnstown, and Lancaster. Cooperating agencies were the State Emergency Relief Board and the Works Progress Administration. In Philadelphia and Pittsburgh Negro families as well as white families were included.

To take account of the difference in economic level among families resulting not only from differences in family income, but also from the number and character of persons dependent on family funds, the families studied have been classified according to expenditure per consumption unit. The consumption unit is calculated on a composite basis taking account of the varying expenditure for food and clothing by persons of different age and sex. For "other items" than food and clothing each family member is counted as one, regardless of age and sex since members usually share equally in such items as housing, furnishings, etc.

Calculation of coefficients of variations for similar data obtained in New York City indicate that average family expenditures for food, housing, and household operation are most stable, while there is great variation in average family expenditures for such items as medical care, transportation, and recreation.

Mr. Howard B. Myers, Director of the Division of Social Research, Works Progress Administration, spoke on "Studies of Relief and Dependency." He described the large unemployable relief population, and pointed out that most of these persons, though not all, will need aid for the rest of their lives. Mr. Myers then discussed separately three broad categories of employable workers now being assisted by the Works Program—the aged workers, the youth, and those in middle-age. The aged workers have the lowest reemployment rate, and the longest periods of unemployment. Few of them are in the skilled group from which private industry is absorbing workers at the

greatest rate. Mr. Myers emphasized the inexperienced youth group, which must obtain work experience to become a useful part of the nation's labor force. The middle-aged workers present no special reemployment problems, he said, as they are the most competent workers and have the highest reemployment rate although a large labor surplus remains in unskilled labor and semi-skilled trades, in which most of these workers fall.

Mr. Myers stressed the need for a carefully planned, integrated, and far-reaching research program in the fields of relief and unemployment. He discussed the topics concerning which future study is badly needed, and expressed his view that a census approach would give little we need to know. In conclusion Mr. Myers posed the alternatives of adjusting our economy to provide adequate subsistence to the bulk of our population, or of taxing a part to support the remainder.

Dr. Thorsten Sellin, Professor of Sociology, University of Pennsylvania, spoke on the relation of crime to the depression. After reviewing the research studies done in this country on this problem and pointing to the lack of agreement in their findings, he discussed at some length the theoretical questions involved in the selection of indexes to criminality, stressing the fact that, generally speaking, investigations which have attempted to arrive at correlations between crime fluctuations and economic fluctuations have failed to examine closely the sensitiveness of the indexes to either.

THE PITTSBURGH CHAPTER.—At the January meeting of the Chapter, papers relating to the forecast for 1937, monopolistic control, housing, and research on stock market movements by the Cowles Commission, presented at the Annual Meeting of the Association in December, were reviewed by Dr. Ralph J. Watkins, Mr. Glenn E. McLaughlin, Mr. Theodore A. Veenstra, and Mr. J. Blair Easter. Mr. Frank M. Kenney reported on the luncheon meeting of the Association Directors and Chapter Representatives.

The meeting on February 20 was attended by twenty-two persons. Mr. Leonard Shapiro, Chief, Income Tax Division, U. S. Internal Revenue Department, spoke on "Your 1936 Income Tax Return."

On March 25 at a meeting attended by twenty persons, Mr. Ralph C. Fletcher, Director, Bureau of Social Research, Federation of Social Agencies of Allegheny County, spoke on "Collection of Social Statistics and Federation Activities."

THE SAN FRANCISCO CHAPTER.—A meeting of the Chapter on February 18, 1937 was addressed by Mr. Bernard Etcheverry of the Division of Analysis and Research of the San Francisco Federal Reserve Bank who discussed "The Measurement of Business Conditions in the Pacific Coast Region."

Mr. Etcheverry pointed out that at least ten composite measures of business activities and many series of a more specific nature were being maintained for the Pacific Coast region. He noted that most of the general business activity indexes were composed principally of electric power pro-

duction or industrial sales of electric power, freight carloadings and bank debits with widely varying weights in the different indexes. He pointed out that each of these components had serious shortcomings. Electric power production is generally included to reflect changes in industrial output, but only 20 per cent of the energy is used in industry. Industrial sales of electric power may be fairly satisfactory as expressed in terms of deviations from normal or trend, but energy consumption in any one industry is not proportionate to the economic importance of that industry and even within an industry highly electrified plants may not be representative of other establishments. Freight carloadings is a good measure of the movement of goods originating in the region, but it does not include shipments by trucks and water-carriers. This deficiency was especially serious during the maritime strike. As a measure of output, carloadings are probably quite unsatisfactory since many goods, such as canned fruits and vegetables, are not marketed for a number of months after they are produced and since carloadings measure the bulk rather than the value of commodities moved by rail. Bank debits are affected by changes in the price level and by transactions which do not represent productive activity, such as corporate refinancing activity and security trading.

The problem of constructing a representative industrial output index is difficult because changes in the output of the most important industries for which current data are available, such as lumber or petroleum refining, are not characteristic of changes of output in other industries, such as canning, for which only annual output data are available. Similarly, the considerable amount of data available on construction is not adequate for the creation of a fully satisfactory construction index. Statistics of employment and distribution likewise reveal an inadequate representation of certain important lines of activity. Mr. Etcheverry indicated that in spite of these deficiencies many of the indexes are of very considerable significance.

THE WASHINGTON STATISTICAL SOCIETY.—The Chapter has held four meetings thus far in 1937. The first meeting, on "Measuring Unemployment," was reported in the last issue of the JOURNAL. It aroused so much interest that on February 17, 1937, a discussion group meeting was held at George Washington University to consider the subject of the application of the sampling methods to social and economic data with special reference to unemployment. Ewan Clague presided. Two hundred and ten persons were present. Since this was a continuation of the previous meeting, no formal papers were presented. Numerous short discussions covering sampling and problems of measuring unemployment filled the entire two hours. The discussion was resumed on April 28.

Another meeting was held at George Washington University on March 12, 1937. The subject was "The Statistical Principles Involved in the Construction and Use of Standard Classifications and Nomenclature." The presiding officer was Dr. Selwyn Collins, U. S. Public Health Service. Ninety

persons attended. The discussion was opened by Dr. Sidney W. Wilcox, Bureau of Labor Statistics, who discussed principles of classification as illustrated by the Heinrich Code for the classification of industrial accident statistics. Coding principles used in the occupational code of the Bureau of the Census were discussed by Dr. A. M. Edwards. Dr. Edwards discussed the main problems of the Census Bureau in classifying occupations so that the same designation will be understood in all parts of the country and in all of the various industries which must be considered.

Dr. Carroll Palmer of the United States Public Health Service presented a paper on coding principles involved in the standard classified nomenclature of disease. He outlined the different methods of classification which could be used, such as classifying according to the symptoms of the disease or classifying according to the parts of the body affected, and then explained the somewhat elaborate classification adopted as a standard. He emphasized the fact that the present nomenclature is designed primarily for use by the specialist and that no general terms are given. Thus it is difficult for a disease to be classified properly by the general practitioner unless a specialist has been called in. Dr. Palmer felt that the present nomenclature is entirely too detailed so that inaccuracy is apt to result from the inability of the physician to diagnose the particular sub-classification of the disease which could be known only to the specialist. Classification principles as illustrated by the International List of Causes of Death were discussed by Dr. Halbert L. Dunn, Chief Statistician, Division of Vital Statistics, Bureau of the Census. Dr. Dunn explained the present list of causes of death as one which must necessarily include every cause which appeared currently on death certificates received by the Bureau of the Census. This list must necessarily contain general items as well as specific items since all physicians are not able to diagnose causes of death accurately. Also the problems of joint causes when more than one disease, injury or other cause is present were important. Dr. Dunn sketched the changing trends in reported causes of death and suggested that a considerable amount of the change was due to better medical training and the ability to recognize a specific disease which could not be diagnosed as such by the ordinary physician of a generation ago.

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REVIEWS

Abstracts of Papers Presented at the Research Conference on Economics and Statistics, held by the Cowles Commission for Research in Economics, at Colorado College, July 6 to August 8, 1936. Colorado Springs, Colorado. Colorado College Publication, General Series No. 208. Study Series No. 21. 119 pp.[1]

This publication affords a condensed record of the proceedings of the Second Annual Research Conference held under the auspices of the Cowles Commission. There are included abstracts of 36 "lectures." Of these, two are devoted to presenting the results of quantitative research in economics. The remaining 34 may be classed broadly under two heads: Statistical Theory and Technique (16 lectures); and Economic Theory and Description (18 lectures).

The abstracts are long enough, in most instances, to give the impression of summarizing well the content of the lectures. Several of them, running from 1,200 to 3,000 words each, deserve to be classed as well-condensed independent papers rather than as mere abstracts. The abstracts on topics in Statistical Theory and Technique run mostly to a length of 800–1,200 words, and those on Economic Theory and Description, mostly to 1,200–2,000 words. In the list given below, asterisks have been added to designate the several abstracts that may stand as well-condensed independent papers and also numerous others that for many readers may serve well in lieu of more detailed discussions already published or yet to be published by the same authors. The judgments thus expressed doubtless reflect in large degree personal reactions of the reviewer and may invite dissent, especially from the contributors; but it is hoped that they may prove useful as a rough guide for potential users of his admirable collection of abstracts.

As published, the abstracts appear in the order in which the lectures were given, except that the four public lectures included in the group are given separate place at the end. The index is by name of the lecturer. In listing the topics here an attempt has been made to achieve a more or less logical arrangement within each of the three broad categories among which I have apportioned them. Topics in quotation marks are titles under which the abstracts are published. I have taken the liberty of adding to the titles of a few of the abstracts, or of substituting for them other statements for the sake of indicating more specifically the nature of the subject matter.

Economic Theory and Description

"Income in Theory and Income Taxation in Practice" (4 lectures).* Irving Fisher.

"Instability in Competition Between Two Sellers," a further development of Cournot's problem of duopoly.* Tord Palander.

[1] A limited number of copies is available from the Cowles Commission without charge.

* More complete and self-sufficient than the usual abstract.

"Remarks on the Theory of Foreign Trade." D. I. Vinogradoff.
"Pseudo-Scientific Economic Doctrine." (2 lectures). Joseph Mayer.
Internal stresses as a cause of changes in the general price level.* E. J. Working.
"Monetary Factors in Trade Cycles, Price Disturbances, and Depressions."* Carl Snyder.
"The Depression, Its Causes and Cures."* Irving Fisher.
"The Accumulation of the Precious Metals in India and China."* Dickson H. Leavens.
"Some Economic Effects of Wage Regulation on Interstate Trade."* C. F. Roos.
"The Capital Supply and National Well Being."* Carl Snyder.
"The Ancient Lineage of Capitalism."* Carl Snyder.
"Whence the Fabulous Wealth and Income of the United States."* Carl Snyder.
"Problems of the International Distribution of Population and Raw Materials."* Corrado Gini.
"Population Analysis." A. J. Lotka.

Statistical Theory and Technique

"The Significance of Regression Coefficients." R. A. Fisher.
"Tests of Signicance in Harmonic Analysis." R. A. Fisher.
"Inverse Probability." R. A. Fisher.
"Significance of Analysis of Variance of Time Series," illustrated by data on stock prices.* H. T. Davis.
"Significance Tests for Periodogram Analysis With Application to Prices of Common Stocks." H. T. Davis.
A comparison of the utility of the partial correlation coefficient and three alternative measures of degree of partial correlation.* E. J. Working.
"A General Invariant Criterion of Fit for Lines, Planes, and Functions Expandable in Series, When All Variates Are Subject to Error." C. F. Roos.
"Methods of Eliminating the Influence of Several Groups of Factors." Corrado Gini.
"On the Measure of Concentration with Special Reference to Income and Wealth."* Corrado Gini.
"Some Observations on the Choice of Function in Curve-Fitting," illustrated by the determination of parameters for an exponential function derived from theory and the fitting of a skew catenary, $r = A + Be^{n} + Ce^{-n}$, empirically determined as the best-fitting function.* C. C. Grove.
Relations of lags and forms of cycles in correlated cyclical series to the arrangement of dots in the scatter diagram and the form of the regression function.* Herbert E. Jones.
"Some Elementary Means and Their Properties."* E. L. Dodd.
"The Chief Characteristic of Statistical Means."* E. L. Dodd.

"The Definition and Consistency of Index Numbers." T. H. Rawles.
"Opportunities for the Use of Statistical Method in Industrial Research."* Anson Hayes.
"Use of Laws of Chance in Industrial Development."* W. A. Shewhart.

Quantitative Analyses of Economic Phenomena

"Evidence of Structure [through time] in Common Stock Prices."* Alfred Cowles 3rd.
"The Effects of Short Selling on Stock Prices."* H. P. Hartkemeier.

HOLBROOK WORKING

Stanford University

Exchange Depreciation, by S. E. Harris, Cambridge, Massachusetts: Harvard University Press. 1936. xxix, 516 pp. $5.00.

Professor Harris' book is monumental, not only in its encyclopaedic survey of statistical data relevant to his theme but also in the exhaustiveness and astuteness with which the facts are analyzed and marshalled into ordered arguments. At times the intricacy of the discussion threatens to overwhelm the reader, even one not altogether unsophisticated in the field; and some of Harris' sentences are quite breath-taking. Sustained concentration and the rereading of passages, however, will be amply rewarded.

It is impossible to give more than a faint suggestion of the scope and the positions maintained in this volume; furthermore, the author repeatedly summarizes his findings, in terminal paragraphs, concluding section chapters, and in an introductory chapter on "Some Major Issues." The remainder of Part I, "Mainly Theoretical," considers the a priori probabilities as to whether and how far devaluation will be matched by rising domestic prices or by declining prices abroad; and it presents a statistical summary of the actual adjustments following 1931. The chief determining factors are elasticities of supply and demand at home and abroad, relative importance of traded commodities to domestic supply and demand and to the foreign counterpoints, the possibility of offsetting increased foreign sales with other balance-of-payments items, the possibilities of monopolistic discrimination, the number of countries already off gold, etc. Actually price adjustments have not in general exceeded 50 per cent; but the resulting export bounty is subject to a number of reductions.

Part II gives an amazingly exhaustive statistical analysis of World Trade, Prices, and Production through the depreciation years. It is not surprising that paper countries have extended their trade; nor that imports into the United Kingdom increased most from countries with a greater decline in exchange rates. But in the case of exports from the United Kingdom, the increase was greatest to countries with greater depreciation, explicable only by the fact that income increases in the latter outweighed the unfavorable trade terms. In general prices rose most in those countries with the greatest currency depreciation. One of Harris' most important findings is

that, so far as concerns volume of production, "exchange depreciation seems to help more by improving the price-cost structure at home, thus contributing towards a more satisfactory business situation, than by capturing foreign trade at the expense of rivals" (p. 179).

The longest Part in the book (III), devoted to the American devaluation, affords the most lively reading. Professor Harris meticulously analyzes the price- and cost-raising tendencies of N.R.A., A.A.A., public works program, and our money and credit policies before ascribing primary importance to exchange depreciation (p. 480). Quite aside from the position maintained, this section is a treasure-trove of information concerning the economic consequences of Administration policies. The paradoxical increase of our imports, the operation of gold purchases, the divergent character of wheat and cotton price-reactions—these, amongst many involved phenomena, Harris treats with a sure hand.

The book concludes with British devaluation, a Part bound to be less novel because of the substantial literature on the subject, but no less excellent. The export bounty Harris believes to be real but less important than other factors determining volume and direction of trade. Hall errs in his adverse criticisms of the Equalization Fund; in 1933 the pound had to drop to prevent hoarding and in 1934 it had to remain low to prevent England's being compelled to supply us with the gold purchased to depress the dollar.

So far as concerns those elements in the international currency situation which are amenable to quantitative statement, Harris' judgment as to the favorable outcome of exchange depreciation seems to be well-founded. But are there not other important factors? Though devaluation helped to raise prices and stimulate economic activity in the devaluing countries, central banks and business communities in other countries suffered intensely under uncertainty concerning their national currencies. In retrospect, the answer might be immediate devaluation paralleling the English action; but after all this is "hindsight" wisdom. Meanwhile uncertainty about what would happen to the franc, the dollar, and even the pound prevented incisive action and helped to perpetuate the economically disastrous "official" parities and exchange control. Furthermore, resort to devaluation was, in the opinion of most central bankers in Middle Europe, precluded for them by an "inflation psychology" holding over from postwar times. Could they be expected to take this perilous step when the future values of Western European currencies could not even approximately be predicted?

There are still other "institutional" factors in the matter of devaluation. Granting that it helped to check the pointless deflation of the 1931–33 period, did it not give hostages to the future by undermining the public's very unreasonable, but from the viewpoint of monetary stability and control, very useful faith in gold? Finally, although Harris discovers a greater gain in the easing of money rates and the expansion of credit following devaluation than in the improved terms of trade, he seems to *attribute* the former to devalua-

tion. For England this is doubtless legitimate; but for the United States and for the gold bloc countries until 1933, it is not clear how devaluation was necessary to credit expansion.

Despite these misgivings the reviewer expects Harris' *opus* to remain the authoritative treatise upon exchange depreciations following 1931.

HOWARD S. ELLIS

University of Michigan

The Reserve Banks and the Money Market, by W. Randolph Burgess, with introduction by George L. Harrison and Benjamin Strong. Revised Edition. New York: Harper and Brothers Publishers. 1936. xxv, 342 pp. $3.00.

In the ten years that have elapsed since the appearance of the first edition of Dr. Burgess' work, far-reaching and disquieting changes have occurred in America's financial organization. Illusions previously cherished have vanished before the realities of the depression. The faith, once so strong, that the Federal reserve banks were a panacea for all economic ills has been dispelled. The conviction, if not the fanatic belief, that the Federal reserve banks could prevent currency panics, mitigate the amplitude of cyclical fluctuations, prevent millions of unemployed from tramping the streets in vain search for work, was demonstrated to be without foundation. Dr. Burgess recognizes the impotence of the Federal reserve system under certain given conditions and emphasizes the point that no central bank can long endure except on the basis of sound banking, economic, and fiscal systems.

What are the more important financial developments which have occurred since the appearance of the first volume? Listing these somewhat in the order of their appearance:

1. The stock exchange panic and the collapse in brokers' loan totals.
2. The bill market débâcle which carried with it general recognition of the fact that a large quantity of the acceptances outstanding in 1929 were from the outset finance bills. These had been drawn largely to meet the working and fixed capital needs of German business, as was brought out in the course of the German bank inquiry of 1933.
3. The increasing virulence of the bank failure epidemic, which had been in progress since the close of the World War and which culminated in the banking holiday.
4. The gold drain of the fall of 1931, when the United States lost more gold than any other nation ever lost in a comparable period of time.
5. The currency panic of the spring of 1933.
6. Unsuccessful attempts to promote recovery on the part of the Federal reserve banks by the purchase of vast quantities of Government securities.
7. The devaluation of the dollar and the assumption by the Treasury of of the control of the money market.

8. The increase of the excess reserves of member banks to alarming totals through gold imports, purchases of domestic gold, through the silver buying program, and through a small use of the profits of gold devaluation.
9. In consequence of the above, the reduction of money market rates of interest to the lowest levels on record.
10. The substitution of bank credit for savings and consumers' income, evidenced by a rapid growth in the holdings of the public debt by commercial banks and by the increase in installment credit.

It is not necessary, in discussing the second edition of this work, to reconsider the excellent treatment of money market organization and technique, inasmuch as all students of the subject are familiar with Dr. Burgess' contribution in this field. In his fundamental theoretical analysis, Dr. Burgess still adheres to what might be termed the shiftability theory of banking. Doubt is thrown on the efficacy of eligibility standards. Evolving quite logically from these premises is the emphasis given to quantitative considerations in the control of credit. At the time of writing he saw no reason to apply credit brakes inasmuch as the volume of credit wiped out by the depression had not yet been restored (p. 303).

In consequence of a vast amount of theoretical work in recent years, increasing emphasis is being placed on *qualitative* norms. It is recognized among a growing number of economists that quantitative control by way of "reflation" of the credit volume involves qualitative deterioration. Thus the artificial stimulus to an increased credit volume (bank deposits) in the United States over the past few years has involved a substitution of bank credit for savings and consumers' income. The interest rate is no longer permitted to exercise its full regulatory function. Productive energies are not being apportioned to the production of consumers' goods and durable goods in the most useful fashion. Consumers' thrift is not being encouraged. Bank profits have become a function of long-term interest rate fluctuations. In consequence of the lowering of qualitative standards, it is all too likely that the present cyclical swing will be greatly amplified.

The proper application of quantitative and qualitative measures of control is admittedly a most difficult problem and one which awaits a full theoretical solution. Doubtless the solution will come about through bridging the gap in theory between bank deposits (quantitative control) and bank assets (qualitative control).

Dr. Burgess doubts whether qualitative control can be successfully applied. His analysis is a mechanistic one, and, in accordance with this point of view, the reserve banks and member banks have little control over the final disposition of credit.

The handicaps thrown in the way of the reserve banks, in view of the monetary preconceptions of the Treasury, in exercising any type of control is recognized in the study. Dr. Burgess rightly maintains that the reserve banks must be free to sell their Government securities, despite the

unfavorable effect of this on the public finances and suggests that the Treasury coordinate its policy with that of the reserve banks.

The interrelations of qualitative and quantitative considerations in credit control are evidenced by the present situation. From the point of view of qualitative considerations, brakes on credit expansion should be applied immediately. To do this, quantitative means must be invoked. A fully developed program would involve the sale of enough securities by the Federal reserve banks to absorb the balance of excess reserves. The profits of gold devaluation should be kept impounded. The silver enactments should be repealed. The interest rate should be permitted to rise and to perform its full regulatory function. This quantitative approach finds its justification in the fact that qualitative standards cannot be applied as long as there are excess reserves. Excess bank reserves have always led to a perversion of banking functions. The reviewer is not optimistic enough to think that any such program will be adopted. The groups that desire the continuance of credit expansion and the maintenance of low money rates are too strongly intrenched to permit effective action to be taken immediately.

BENJAMIN HAGGOTT BECKHART

Columbia University

America's Experience as a Creditor Nation, by John T. Madden, Marcus Nadler, and Harry C. Sauvain. New York: Prentice-Hall, Inc. 1937. xvi, 333 pp. $3.50.

It is probable that the subject in the field of international economic relations most neglected by contemporary literature has been that relating to the foreign investments of the United States. As a consequence, loose talk and fuzzy thinking have often usurped the position of fact and logic. This new book analyzing America's experience as a creditor nation will serve admirably in clearing the air, first of all because of the factual material here presented for the first time concerning the foreign lending of the United States, and secondly because of the careful analysis of these data.

The Department of Commerce has calculated the long-term investments of the United States at the end of 1930 at about fifteen billions of dollars, nominal value, about half of which consisted of direct investments and the other half portfolio investments. The authors of this book, aware of the immense practical difficulties and the uselessness of an attempt to calculate the actual value of our direct investments abroad, have been content to accept the Department of Commerce's book and nominal values of such investments and to draw, with discernment, no more than modest conclusions therefrom. Their analysis [illegible] almost wholly portfolio investments. Here again they simplify the problem, and again with justification, by stating that the "greater part" (in fact it appears to be about 90 per cent) of our portfolio investments consist of foreign dollar bonds issued in the United States, and by confining their analysis to these foreign dollar bonds.

In the twelve-year period 1920 to 1931, inclusive, according to the Department of Commerce there were publicly offered for sale in the United States foreign capital issues to a value of $11,623,000,000. Of this amount $1,754,000,000 consisted of refunding issues, the net nominal capital being $9,869,000,000. The authors object to this figure because it includes bonds of United States possessions, stocks of foreign corporations representative of ownership, securities of American corporations to the extent that the proceeds of the sale of such securities were used by the issuers for investment abroad, and foreign currency bonds, stating that it exaggerates the extent to which the American public actually loaned its money abroad through the medium of foreign dollar bonds. Their own calculations, excluding the foregoing types, disclose a total of $9,364,000,000 of foreign dollar bonds floated during the period, inclusive of refunding bonds.

Of all the foreign dollar bonds that have been issued since 1920, extensive research on the part of the authors discloses that bonds of a nominal value of $7,490,000,000 were outstanding at the end of the year 1935. (Of this amount, not more than $4,130,000,000 nominal value, were estimated to be held in the United States on that date, and the actual value of these bonds held in the United States at the end of 1935 must have been less than $3,000,000,000; however, in their various computations concerning defaults and the rate of return, the authors employ the figure representing the total amount of bonds issued in the United States and outstanding at the end of 1935.) On 61.5 per cent of the foreign dollar bonds outstanding at the end of 1935, debt service has been paid in full; about 37.5 per cent of the bonds are in default as to interest and about 1 per cent are in default as to sinking fund or principal only. Of the bonds in default, payments on about one-third continue to be made in cash (foreign currency), scrip, or funding bonds. By comparison with depression defaults on groups of outstanding domestic bonds, the authors conclude that investors as a whole in foreign dollar bonds have fared relatively well. Defaults were largely concentrated in Latin American and certain European countries, notably Germany.

The authors proceed with various interesting studies concerning the financial results of American foreign lending. For example, they find that the total payments made to bondholders in cash on account of principal and interest in the years 1920–1935, plus the market value of the securities outstanding at the end of 1935, were considerably greater, even considering defaults, than the amounts paid for them in the first instance; indeed, by an elaborate accounting, they calculate that the average of the annual rate of return on all foreign dollar bonds in the period 1920–1935 was about 6 per cent. This figure again takes into account all defaulted bonds.

In a chapter on the effects of capital exports upon various phases of economic activity in the United States, the authors reach the conclusion that the economic effects of foreign loans on the United States have been considerably less important than is generally believed; that in so far as our our foreign loans stimulated our export trade the effect on commerce and

industry was favorable; but that the export of capital failed on the whole to bring lasting benefits to the United States because throughout the post-war period this country followed a policy of restricting imports when its position as a creditor nation demanded precisely the opposite course. Defaults were caused primarily not by the uneconomic nature of the investments themselves but by the inability of the debtors to transfer local funds into the currency of the United States, and the transfer problem has been largely the result of uneconomic restrictions on the free flow of trade.

The book possesses other chapters of general economic and historical interest which make it a well-rounded and readable study of the foreign investment policy of the United States.

In view of the general worth of the book, minor faults can perhaps be overlooked. There is one, however, which deserves mention. That is the failure of the authors to bring out with sufficient clearness and at the beginning of their analysis the relation of foreign dollar bonds to the total of our portfolio investments; also the relation of their computed figures to those published by the Department of Commerce is not in many cases as clear as it might be.

Joseph M. Jones

Washington, D. C.

The Problem of Investment, by F. I. Shaffner. New York: John Wiley & Sons, Inc. 1936. viii, 357 pp. $3.00.

Most predepression books on investment oversimplified the problem and underestimated the risk faced by the investor. The postdepression tendency has been to cull, from the none too encouraging record of the past six years, materials for what are, in effect, investors' chambers of horrors.

Dr. Shaffner's book is free of criticism on these counts. He has, indeed, exploded some of the time-worn myths of investing and has dealt realistically and convincingly with many of the pitfalls and detours in the road to successful investing under the complex and uncertain conditions prevailing today. As a basis for his discussion he has presented an appraisal of those investment risks which have their origin in rapid economic change, in the tendency to divorce corporate control from corporate ownership, in the existence of dual interest among the investment institutions serving the investor, in the deterioration of certain legal safeguards for the rights of the security holder, and in the business cycle.

But Dr. Shaffner has not been content to emphasize the importance of risk in investing without exploring the avenues of escape from these risks and appraising the various means by which the position of the investor may be protected by his own and society's efforts. Among the many possible measures for protecting the investor which are considered by Dr. Shaffner are the following: The establishment of uniform accounting methods and standardized corporate procedure, the "concentration of voting power in the hands

of voting trustees" to represent the interests of security holders, the development of institutions to "consolidate the interests of scattered investors," representation of minority stockholding groups on directing boards, the regulation of holding companies, Federal incorporation of business enterprises, resort to the doctrine of trusteeship in corporate management, blue-sky legislation, and the regulation of stock exchanges.

The conclusion to which Dr. Shaffner comes is not encouraging. He appears to consider it unlikely that the "rules of the game" will be changed to eliminate the major risks of investing, and he seems to be convinced that the investment problem is so complicated and the risks are so great that the investor cannot, by the exercise of reasonable care, assure the avoidance of those risks. The author concludes that "no layman should attempt to handle his investment unaided, any more than he would try to diagnose his own disease if he were ill"; but his enthusiasm for the investment expert is tempered with caution, for he states that "even with the aid of experts, however, the investor must make some study of the subject himself in order (1) to pick out the best advisers in the first place and (2) to appraise from time to time the quality of the advice he is getting."

Many of the problems upon which Dr. Shaffner has touched might well be the subjects of more extensive treatment than he has accorded them in his book. Nevertheless, he has rendered a distinct service in bringing these questions to the foreground of current discussion and in assembling much of the data necessary for their further consideration.

MURRAY SHIELDS

Irving Trust Company
New York

The Undistributed Profits Tax, by Alfred G. Buehler. New York: McGraw-Hill Book Co., Inc. 1937. ix, 281 pp. $2.75.

The Federal tax on undistributed profits, incorporated in the *Revenue Act of 1936*, has provided the field of corporate taxation and finance with the most heated controversial issue for a good many years. It was passed as an Administration measure in the face of almost solid opposition on the part of business interests. Unfortunately, as is so often the case, the opposition has not hesitated to mix unreasoned and unsound argument, convincing to the uninformed, with logical and sound objection to the end that popular support might be enlisted. Professor Buehler has performed a valuable service in giving the ordinary citizen an opportunity to judge this tax measure in the light of reason, shorn of hysterical and unjust criticism.

It is not necessary to proceed far into this study to discern that the author is not in favor of the undistributed profits tax. In fact, the main criticism that the reviewer would raise is that it develops into an almost too perfect logical condemnation of the tax. Professor Buehler fairly presents both sides of each question as it is raised, states his own position, and modestly admits

that his conclusions are tentative and may have to be revised in the light of more information and experience. Nevertheless, he invariably finds that the tax is unsound on every count except that of expediency. Even if one grants that the tax in its present form falls far short of perfection or that it may be a monstrosity, the evidence is not conclusive that some merit may not attach to the taxation of undistributed profits.

Professor Buehler sets out "to describe the features of the new tax law, to state some of the economic and fiscal problems of the Undistributed Profits Tax, and to appraise it tentatively as a member of the federal tax system" (p. vii). First he presents the immediate background of the tax followed by statements of certain proponents of a tax on undistributed profits, notably those of Professor Tugwell. He traces its progress from the President's proposal of March 3, 1936, and the deliberations of both houses of Congress to the final compromise measure of the conference committee which was finally passed and signed late in June. There follows a very full statement of the tax provisions and a brief mention of somewhat similar taxes in other countries. Chapter IV on the extent of corporate undistributed profits of recent years, drawn from a number of recent statistical studies, results in the following conclusions: first, that there was no marked tendency for corporate saving to increase in the period from the World War to 1930; second, the data fail to reveal that an increasing percentage of profits was being saved during this period; third, that it must remain a matter of opinion as to whether corporations saved too much; and, finally, that if corporate saving was honeycombed with abuses, it seems likely that noncorporate saving might have been accompanied by somewhat similar abuses (p. 83). The statistics presented in this chapter are those taken from *America's Capacity to Consume*, from Treasury estimates in *Senate Hearings*, 1936, and from a Department of Commerce publication, *National Income in the United States, 1919–1935*. In addition, reference is made to certain estimates of W. I. King, W. A. Paton, R. R. Doane and others. There are a number of reasons why these studies probably minimize the extent of corporate saving. In the first place, these estimates are based on reports prepared by all corporations for Federal income tax purposes. There is no necessary reason why such income reported for tax purposes may not be considerably less than the income reported to the stockholders. Secondly, most studies purporting to show the amount of corporate saving are in reality showing the net increase or decrease in corporate capital. The reviewer is convinced that the amount of corporate saving is much greater than that shown in these estimates. On the other hand, it is quite possible that additional information would not offer sufficient evidence to change the above conclusions.

The rest of the chapters consider "economic and fiscal" aspects of the tax. Professor Buehler finds it curious that an administration professing sympathy for the small corporation has sponsored tax measures that are "kind to existing monopolies" (p. 104). Large companies with previously accumu-

lated surpluses are not only fortunate in that the tax applies only to future savings but are aided by the effect of the tax in retarding the growth of small competitors, largely dependent upon this source of new capital. He finds also that large companies probably need to save a smaller proportion of profits, thus avoiding the higher brackets of the progressive tax, and that these companies can tap sources of new capital not open to their smaller rivals.

Some of the sponsors of the tax have hoped that corporate dividends will permanently increase as a result of the tax. Professor Buehler is not so sure that this will be the case. After allowing for the pressure of progressive rates in forcing dividend disbursements and the various cases where corporations will prefer this method of avoiding the tax, he cites no less than ten powerful counter tendencies. The marked increase in dividend payments following the adoption of the tax measure is discounted as an index of the future, largely because of the newness of the tax. The author is not convinced that other corporate reforms will automatically follow the taxation of undistributed profits. His position is rather clearly presented when he states, "One wonders if a more constructive attitude on the part of certain critics might not go farther in preserving the corporation as an institution of vast business and social benefit than the destructive tactics displayed recently in the discussion of the undistributed profits tax" (p. 142).

One of the best chapters of the book deals with the subject of taxation and economic stabilization. Professor Buehler first discusses the wide variance of opinion as to the nature and causes of business cycles showing that the various "oversaving" theories, upon which the undistributed profits tax as a reform measure is based, fall far short of unanimous acceptance by economists. It is the author's opinion "that the available evidence does not justify the adoption of an undistributed profits tax . . . as a measure intended to advance prosperity and economic stabilization" (p. 175). In fact, he inclines to the view that such a tax may have the opposite effect, causing instability and involving grave social risks.

Despite the fact that the use of taxation for regulatory purposes is by no means new, the author finds that this particular tax is unwise as a regulatory measure for a number of reasons. First, although the objective of those who seek economic stabilization by means of this tax is commendable, he finds that it is primarily a revenue measure and does little to assist toward better control over economic conditions. Second, the desirability of retarding large and preserving small corporations is highly controversial, but, even if accepted as desirable, he feels that this tax would be the wrong means of producing this object. Third, on the matter of increasing stockholder control of corporate affairs, particularly dividend policy, he feels that this tax would entail more social loss than gain. Finally, he questions both the desirability and effectiveness of this means of attempting to bring about a more equitable distribution of wealth and income.

Not even as a revenue measure does Professor Buehler find the tax desir-

able. Following an examination of the measure in accordance with the "traditional principles of business taxation" (cost of service, special privileges, silent partner, ability to pay, remedy of inequality), he concludes that the ruling principle here involved is that of expediency, arising out of revenue needs and political circumstances. The complexity of the tax and the administrative difficulties entailed are stressed in pointing out further fiscal weaknesses of the tax. Inconvenience and uncertainty harass the corporations, and various methods of avoidance, some nine of which are discussed, likewise produce uncertainty for the Government. Appraising the tax from the angle of Federal revenue, the author maintains that it will produce an uncertain revenue, is extremely complicated, introduces new complexities into the system, may be held unconstitutional, and may influence payment of dividends contrary to state laws.

Following a short discourse on the "system" (if such it may be called) of Federal corporation taxes, in which the whole program of graduated rates for corporations is brought in question, the author summarizes briefly the strongest array of arguments against the undistributed profits tax that has so far been made available to students of the subject. For those who agree that the case for the taxation of undistributed profits is hopeless, this is a very excellent handbook. The reviewer is not so firmly convinced as the author that a tax on such profits may not be a necessary complement to the present "system" of corporate taxes. The present law was hastily prepared and suffers from the admixture of reform, regulatory, fiscal, and political considerations that prompted its passage. It has aroused such a storm of opposition that its future seems unpromising. Nevertheless, some such tax, provided it does not discriminate against the corporate form of business, is a promising means for eliminating at least some of the inequities of Federal income taxes. In fairness to Professor Buehler, he has not overlooked the possibility of a satisfactory tax on undistributed profits, which he says, "should be employed as a revenue measure . . . " (p. 270). The reviewer feels, however, that Professor Buehler could have increased the value of his book greatly by a discussion at greater length of the ways and means of providing an equitable tax on the undistributed profits of corporations.

J. ELLWOOD AMOS

University of Pittsburgh

Ernteschwankungen und wirtschaftliche Wechsellagen 1874–1913, von Georg Brandau. Jena, Germany: Verlag von Gustav Fischer. 1936. Beiträge zur Erforschung der wirtschaftlichen Wechsellagen Aufschwung, Krise, Stockung. Herausgegeben von Arthur Spiethoff. 107 pp. Rmk. 4.50.

It is of particular interest for the writer to review this short but rich-in-content study as he had opportunity seven years ago to analyze the same problem in relation to American cycles. Arriving at certain conclusions con-

cerning the relationship between agricultural and business cycles in America, the writer suggested at that time that it would be advisable to continue the study on a world scale. Mr. Brandau undertook this task, following lines similar to those used in the writer's study and extending his analysis to twelve countries, six of which are European and six on other continents, about equally divided into industrial and agricultural countries. As can be seen from the title of his study, Mr. Brandau limited his analysis to the forty prewar years. It seems reasonable that he eliminated the war and the postwar period from his analysis, as the war and the postwar inflations affected various countries in such different ways that it is practically impossible to treat them together.

Mr. Brandau constructed for each of the twelve countries the following indices: (a) crop production, (b) crop prices, (c) total value of crops, (d) industrial prices, and (e) purchasing power of crop products in terms of industrial products. For most of the countries these indices are based on five to eight principal crops, characteristic of the respective countries. Among these crops the cereals figure for practically every country, but there are also such crops as cotton, flax, sugar beet and cane, coffee, tea, vines, etc. From these indices for separate countries he builds world indices representing the weighted averages of deviations of indices for separate countries from their respective trends, determined in the form of moving averages.

Analyzing indices of crop production and of crop prices for twelve countries, Mr. Brandau revealed the existence of cyclical fluctuations in these indices, the typical duration of which is very close to that of the business cycles established by Professor W. C. Mitchell from his study of the business annals in 17 countries. The frequency distribution of crop cycles by their duration, based on 104 observations, is surprisingly similar to that of Mitchell's for the business cycles, showing a modal duration for the crop cycle of three years and the next to modal duration of four years. Because of the concentration of high and low points in the indices for separate countries around certain years, the world index of crop production, as well as the world index of crop prices, combined from the indices for separate countries, also reveals well-pronounced cycles, although of somewhat longer duration.

Mr. Brandau was rather disappointed by the fact that he could not discover close relationships between the cycles in agricultural indices and the business cycles by individual countries, at least as close as those which were established by the present writer for the United States or by Professor S. A. Pervushin for Russia. But it was natural to expect this result, as most of the other countries depend more on the situation of the world market of agricultural products than on their domestic agriculture, which is usually not important enough to affect substantially the world situation. However, comparing the world index of crop production (constructed as explained above) with the business fluctuations, he could discover a relationship: that business revivals usually occurred in the years (or around the years) of large

world crops, and that recessions followed the small world crops. He noted that this relationship was closer during the earlier period of falling prices (from the 1870's to the middle of the 1890's) than in the later period of rising prices. This last observation was made earlier by Professor Pervushin and was confirmed by the results of this writer's study of American cycles.

Establishing that the business cycles in large industrial countries are in fairly close relationship with the rythmical fluctuations of *world* crops, Mr. Brandau could not find such definite relationships between the business cycles and the total value of world crops or the purchasing power of agricultural products. In his opinion, it must be explained by the fact that these last depend on prices of agricultural products which are not direct functions of the natural agricultural rhythm but depend on many factors changing in time. He found that for the early period (1874–1896) there was a fairly close negative correlation between his world index of crop prices and the world index of crop production, while during the later period no such correlation existed.

In the reviewer's opinion it would be desirable to build the world index of crop prices in a different way from that followed by Mr. Brandau. His world index of crop prices is an average of the indices of crop prices for individual countries, after elimination of their trends. He recognizes that such an index does not represent at all the movement of prices in the world market. In order to have a world index of crop prices more representative of prices on world markets, it would be better to take prices of several important agricultural commodities on the leading world markets and to construct an index based on them. This index could be compared with the world index of crop production constructed for the same leading world crops. Such a method would permit one to proceed further in the analysis of the importance of individual crops, such as wheat, or cotton, or sugar, in the business fluctuations. This would complement Mr. Brandau's analysis by countries.

Presenting a great deal of interesting factual data, Mr. Brandau does not go very far in their theoretical analysis. He points to multiple connections between the agricultural fluctuations and business cycles which are changing with time or even from one cycle to another, and for this reason he cautions against explanation of these relationships on the basis of any one rigid theory. This pluralistic point of view of the author may be regarded as correct.

The writer has several differences with the author in the interpretation of some of the facts, but it is impossible to go into these discussions because of the lack of space. The value of the study is in the presentation of rich factual data and their careful interpretation. Appendix tables on 38 pages supply for each of the twelve countries data used in the computation of the indices and the charts illustrating these indices. These facilitate further independent analysis of data by the reader.

By this publication the author has substantially contributed to a better understanding of the complex relationship between agricultural and in-

dustrial cycles, which subject during the recent depression began to attract greater attention than ever before. The reviewer recommends, Mr. Brandau's study to all interested in this problem.

V. P. TIMOSHENKO

Stanford University

Agricultural Prices, by Frederick L. Thomsen. New York. McGraw-Hill Book Company, Inc. 1936. x, 471 pp. $4.00.

As far back as 1920 many of the spokesmen for agriculture out in the states had already formed the habit of telling the professors of economics in the agricultural colleges that their vaunted law of supply and demand was no longer true. What they meant to say had as much truth in it as most sweeping generalizations in economics. The difficulty was in their manner of saying it. They meant to declare that the assumption of free competition upon which economists were then wont to base their analysis of price determination was no longer in keeping with the facts of economic life. But many teachers of economics insisted upon taking them literally and rising to the defense of the law of supply and demand. Professor Thomsen grew up as a teacher of economics in the College of Agriculture at the University of Missouri and no doubt felt called upon frequently to explain to agricultural leaders the heresy of their views. At least he seems to have developed a course in "agricultural prices," and a textbook to accompany it, which are almost wholly in terms of the assumption of a largely free working of the forces of supply and demand. Four pages are the most that can be found in any one place devoted to competition, and these mostly declare its efficacy and almost all-sufficiency as an explanation of price movements. The price theory presented is wholly in terms of the supply and demand curves of free-competition economics—not a word of the theory of imperfect competition. No doubt most of the teachers of courses in "prices" in agricultural colleges still find themselves sometimes confronted by the same heresies as was Professor Thomsen and will find this textbook falling in with present conceptions of their needs. But the day is nigh when this will no longer be so, and it is to be hoped that the author will find an opportunity presently to broaden his treatment in a new edition.

Another outstanding feature of this textbook is its reliance in undue measure, in the reviewer's judgment, upon the procedures of "graphic multiple correlation" as means of isolating the demand and supply curves of economic theory. The chapter on the technique of graphic correlation analysis is the best brief presentation of it now available; but in only one paragraph is mention made of the frequently overmastering difficulty of intercorrelation between independent variables; and not a word is said about non-additive relationships.

Of course it may be said that these are complications beyond the reach of the undergraduates for which this textbook must mainly have been planned.

But for that matter so is this whole chapter on graphic correlation. This serves as an example of a considerable unevenness of the level of treatment of the various subjects covered in the book. Otherwise, the selection of material to be presented is commendable for the purpose in hand. The early chapters present a simple undergraduate theory of equilibrium price. Then follows two chapters on artificial price-raising measures, six not so simple mostly on methods of price analysis, and seven on prices of groups of farm commodities. These last chapters bring together in brief form the results of most of the extant analyses of prices of individual farm products

JOHN D. BLACK

Harvard University

Volkswirtschaftliche Theorie der öffentlichen Investitionen, by Hans Richter-Altschäffer. München und Leipzig, Germany: Verlag von Duncker & Humblot. Eine Untersuchung über die theoretische Stellung der öffentlichen Investitionen in der Dynamik der modernen Verkehrswirtschaft. 1936. iv, 155 pp. R.M. 5.80.

This is a deductive justification of the policy of business stabilization by public works, touching only incidentally on fiscal questions and methods of administration.

The book is up to date in the emphasis it places upon anticipations in determining the investments of entrepreneurs—whose functions are distinguished sharply, as by Schumpeter, from those of routine business men. Examining in some detail the elements influencing these entrepreneurial decisions, the author concludes that such corrective reactions as are set up by depression (principally lowered costs) may be offset indefinitely by the reactions hostile to equilibrium (working principally through breakdown of confidence and credit). He emphasizes his belief that there is no automatic process turning depression into revival. The depression, like the boom, is cumulative and contrary to equilibrium; but whereas the boom is limited by the scarcity of production factors, the depression is limited only by the extinction of capitalistic production. This is not a new point of view; but the author gives it a clear and persuasive exposition.

As is pointed out in a "Digression on Business Cycle Theory," such a view is incompatible with the concept of a "cycle" as a succession of stages each of which evolves into the next. It would seem more akin to the early idea of catastrophic "crises," except that here the catastrophe begins as a boom which evolves into the crisis and finally the depression, which lasts until some lucky combination of events gives rise to another boom.

Since depressions do not cure themselves, the author views stabilization as a peculiarly public function. Public investment should be judged, accordingly, by its conjunctural effects on private production and employment, not by its profitability in the narrow sense. The objective is pump-priming rather than revenue.

The author enumerates in some detail the components of saving and investment, so defined that when saving is equal to (the price of new) investment, the returns to producers of currently consumed goods are just equal to costs, including a sufficient profit to justify the continuance of production on the same scale. It is not made quite clear, however, whether the equality of saving and investment is to be considered a sufficient or merely a necessary condition of stability.

When wages and prices are pursuing divergent trends, we are told that neither should be allowed to fall. In periods of increasing efficiency, the author favors stabilizing prices and letting wages rise; in periods of decreasing efficiency, he would stabilize wages and let prices rise.

Little that is new is found in the refutations of the orthodox arguments against public works. Nor has the author anything definite to offer as criteria of the business situation. He quotes with approval a list of indicators, such as prices, employment, idle capacity, inventories, and interest rates, but does not specify how these are to be combined. Nor does he suggest the compilation of any new measures of saving or investment.

There are few figures in the book, aside from some interesting data on dwelling construction and public works in various countries and some estimates of investment in Germany. Worthy of note is the convenient summary (pp. 129–138) of the development of the idea and policy of public works, and the useful bibliography. In the elaborate analysis of the components of saving and investment which occupies more than half the book, the statistically inclined economist will find many empty economic boxes and much stimulation to set about filling them.

EDGAR M. HOOVER, JR.

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Business Cycles and Forecasting, by Elmer C. Bratt. Chicago: Business Publications, Inc. 1937. xiii, 501 pp. $3.50.

Although economists generally deny the possibility of overproduction, there has clearly been a surplus output of textbooks in most lines of economics and business. Business-cycle analysis does not share this embarrassment. On the contrary, the subject has lacked a general textbook appropriate for an introductory course.

Professor Bratt's book is more general than the title suggests, owing to a liberal assignment of space to the broad question of economic change. The cylical focus of the subject matter, however, is kept continually in the foreground. The result is a textbook well suited to the needs of students who are embarking on the study of business cycles. Although there are almost 500 pages of text, the treatment does not and cannot go deeply enough to meet all the requirements of advanced courses and retain the scope and balance required of an introductory offering. It may, however, serve reasonably well

in advanced work as a coordinator for selected readings. References and study questions at the end of each chapter are helpful for this purpose.

An adequate treatment of business cycles must be partly theoretical, partly statistical. This book succeeds in getting a balanced mixture of both elements. The material is well planned, and the method of presentation is direct. Topical groupings are as follows: (1) nature and measurement of seasonal variation and of long-time trend, (2) statistical methods for measuring and analyzing the business cycle, (3) factors responsible for cyclical fluctuations in business, (4) theories of business cycles, (5) business-cycle history, including a lengthy discussion of the depression of the 1930's, (6) schemes proposed for artificial control of cyclical movements, (7) stabilization of business, (8) business barometers, (9) characteristic fluctuations of the business cycle, and (10) problems and methods of business forecasting. Two chapters are devoted to the "great" depression. There are 40 charts, most of them reproductions from other publications. Heterogeneity in the charts is avoided by careful selection and reproduction. This generous representation of charts from other published sources, however, has the disadvantage of including many time series in which data for recent dates are not shown. Redrafting of these charts, in part at least, to include up-to-date material would have been an appreciable improvement.

In the main, *Business Cycles and Forecasting* is not an essay in a particular business-cycle doctrine. It leans heavily on the side of skepticism of ability to do anything constructive to control business cycles. Professor Bratt's point of view is best summarized in the statement (p. 319): "the cycle is a natural concomitant of the elastic recurrence of human functioning. It allows trial and error, and at the same time permits us to avoid the cumulative effect of errors." Depressions are safety valves, preventing eventual explosions.

The only remedy given a hearty reception is facilitation of decline during the recession phase of the cycle. Professor Bratt prefers to take price subsidence and bankruptcy in one gulp. "Prolongation of depression by artificial intervention" is considered to be "the most prolific cause" of failures during depression.

Suppose that there is a relationship between failures and artificial prolongation of recession. Is the solution of the problem adequate? Is it rational to concentrate on hastening the patient through the disease after he has contracted it, without doing anything of consequence to prevent further contagion? Perhaps the medical profession is favored by easy access to preventive measures. On the other hand, should business-cycle analysts abandon all hope for preventive action? Whatever the degree of optimism, it is at least questionable procedure to consider the development of "unsound economic positions" as defensible "human functioning," whereas the severity of depressions is attributed in large part to indefensible "artificial intervention" in the recession period. Unfortunately Professor Bratt takes a

strong position on this problem in his book which in other respects has the impartiality and scope desirable in an introductory treatise.

WILBERT G. FRITZ

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Electric Power in Syria and Palestine, by Basim A. Faris. New York: Oxford University Press, Inc. (Agents). Printed at the American Press, Beirut. 1936. American University of Beirut. Publications of the Faculty of Arts and Sciences. Social Science Series No. 9. xx, 367 pp. 8*s*. 6*d*.

In his book (of 203 pages exclusive of appendices), Professor Faris traces the development of the electric industry in Palestine and in French Mandated Syria since the War. He endeavours to point out its public duty and its economic opportunity as a force in the industrial rehabilitation of those areas, in the improvement of the standard of living of their inhabitants, and in the attainment of a modicum of independence through the harnessing of natural resources. Although his public will be predominantly local, those who are interested in the problems of load development under peculiarly trying circumstances, those who would know more of the economic potentialities of these Biblical lands, and those who seek further verification of the conclusion that man seldom learns through vicarious experience will find much to interest them in *Electric Power in Syria and Palestine*. Those, however, who seek new light on the economics of electric utility operation, the determination of rates, or the analysis of costs, will be disappointed. Professor Faris demonstrates a profound knowledge neither of public utility economics nor of regulatory practice, and his analysis suffers unavoidably from the lack of important kinds of data and the inadequacies of many that were available.

Perhaps because he wrote primarily for a local audience, the mere form of presentation may irk the American reader. There is a detailed itemization of physical plant, of capitalization, and of the rate structures of the six utilities more specifically analyzed. Some confusion is caused by local currencies—more troublesome than foreign physical measures because they vary among themselves—which are seldom translated, either in table or text, into American equivalents.

But more striking in a study which purports to be an analysis of relative operating efficiency and rates is the absence of cost data of any description and of load curves either for the companies or for the classes of customers served. Professor Faris seems impressed with the efficacy of promotional rates and the conception that rates determine costs in the electric industry to the exclusion of all qualifications (by implication) of this principle admittedly true in general. His analysis of rate schedules, therefore, becomes no more than an editorial check upon their promotional character but even this is marred by a failure to consider very pertinent factors. The price and finance terms for electric appliances, the average money income by classes

and the percentage of this income spent upon substitutes for electricity, the incidence of an increase in domestic demand under the more promotional rates relative to the company's peak—these data, if available, might establish some presumption for or against the efficiency of the promotional rate. Professor Faris preaches the gospel of lower rates but in the absence of supporting evidence he must rely on a comparison of average bills, average unit costs, and average customers for the United States as a whole, by major divisions, and for the Springfield Electric Company (Mass.), the Hartford Electric Light Company (Conn.), and for St. Catherines, Ontario, in particular. It need not be pointed out specifically why such a comparison is worthless to prove anything about the fairness or the business acumen displayed in electric rates in Syria and Palestine.

By implication the reader gathers that cost and load data are unavailable for the companies studied, and explicitly it is pointed out that income and financial information are inadequate for most. It is the more difficult to understand Professor Faris' conclusion that "... in both Palestine and French Mandated Syria the proper mechanism is provided in theory for effective regulation, and there should be no fear of unfair practices by public utility companies" (p. 222). Because the two companies in Palestine have good public relations and, with falling rates, have proved successful financially while those in Syria have suffered by comparison, it is not obvious, without far more evidence than Professor Faris marshalls, that regulation in the first instance "has shown very satisfactory results" (p. 228) but has failed in the second (p. 229).

Professor Faris demonstrates considerable ingenuity in estimating potential load from very sketchy data, but his survey of water power resources would be more meaningful if one were given some conception of the cost of harnessing and transmitting this energy to the load in comparison with the cost of steam or oil generation in this section of the world.

Lest the reader misinterpret the object of these criticisms, it should be emphasized that Professor Faris has done a very careful and painstaking job with very inadequate data. These reservations would not be stressed if, in his analysis and in his conclusions, he had shown a keener appreciation of their existence and their significance.

MELVIN G. DE CHAZEAU

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Determination of Confusion in Trade-Mark Conflict Cases, by Neil H. Borden. Boston, Massachusetts: Harvard University, Graduate School of Business Administration Bureau of Business Research. George F. Baker Foundation. Volume XXIII, Number 8. December, 1936. Business Research Studies Number 16. vi, 34 pp. $1.00.

Following a careful historical review of psychological studies of trade-mark confusion among consumers and of litigation based upon charges of trade-mark infringement, Professor Borden presents the recognition and

recall tests used in the John B. Stetson Co. v. Stephen L. Stetson Co. case. From experience with application of these tests the author concludes that valuable evidence for judging the likelihood that consumers confuse trademarks may be derived through this procedure and that courts would facilitate decisions by admitting such evidence.

The author recognizes the limitations of his samples of men tested and claims that the results should be accepted only as a general indication. As in Business Research Studies, No. 12, by T. H. Brown, Professor Borden applies simple probability formulae with careful, concise statements of procedures and of limitations that should prove of practical value to students of sampling.

JOHN H. COVER

The University of Chicago

Population Distribution in Colonial America, by Stella H. Sutherland. New York: Columbia University Press. 1936. xxxii, 353 pp. $4.00.

Miss Sutherland's book contains thirty-five tables, three useful and original population maps, and a rather extensive bibliography (xvii–xxxii). She has divided the subject by geographical divisions, as follows: "New England," "New York," "New Jersey," "Pennsylvania and Delaware," "Virginia and Maryland," "North Carolina," "South Carolina," and "Georgia." The textual materials, in nature, are historical (economic and social) and political geography; they are interwoven and illustrated with population data into a pleasing, readable, informative, unitive but chronological story. The bibliography, which is arranged in alphabetical order, is not a critical one, but in the introduction to the story there is an explanation of the difficulties which beset the researcher in this field of population movements. The appendix is a series of tables listing the important imports and exports to and from the colonial ports of America under the English commissioners (Jan. 5, 1771–Jan. 5, 1772). The statistical tables at the end of the chapters and in footnotes showing the white and black population of towns, communities, and counties in the different colonies are of particular value, since there was no census taken by some of the colonies and the census of 1790 is inadequate for our present-day needs. Lists of kind and quantity of taxables are included. Data based on estimates are so indicated. The author's sources were limited according to records varying in quantity from colony to colony, a fact which is pointed out, and naturally the conclusions must be considered more or less valuable depending upon the quality and amount of information available. A tremendous amount of time and energy must have been spent on old newspapers, tax lists, pamphlets, and other sources, in gathering the information which is crowded into this volume. The student of population movements in America as well as the authority on the subject will find it a handbook of ready reference, and the historian may welcome it for its interesting light on frontier history and the methods used in founding

new communities. The author's style is lucid; her conclusions are carefully drawn. A characteristic conclusion is one on the population density of New England about the end of the colonial period, and after a presentation of data: "Generally speaking, density appears upon the map in direct proportion to natural resources and to accessibility by water. Thus, all other things being equal the best agricultural regions attracted the early settlers, the river valleys being particularly desirable because of the ease with which they could be reached" (p. 37). Again, on New Jersey: "The idea of a town was always present in the New England mind, but of all the New Jersey communities, only one, Perth Amboy, seems to have been laid out with the prayer that it might one day become a city" (p. 118); and, finally, "the history of colonial America is the story of land" (p. 272).

William E. Smith

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Expenses and Profits of Limited Price Variety Chains in 1935, by Stanley F. Teele. Boston, Massachusetts: Harvard University. Publication of the Graduate School of Business Administration. Bureau of Business Research, Bulletin Number 103. Volume XXIII, Number 7. October, 1936. vi, 30 pp. $1.00.

This is the sixth of a series of annual studies of the operating figures of limited price variety chains which began in 1929 and has continued since that time with the exception of the year 1930. The current report covers thirty chain systems operating a total of 4,974 stores selling a net volume amounting in 1935 to $742,112,383. The Harvard Bureau of Business Research, which is responsible for the study, estimates that the reporting firms did approximately 90 per cent of the total business of this type which was done in the United States during that year. The 1935 Census of Distribution reported a total of 5,658 stores engaged in the variety trade. Their total sales were $709,000,000. The discrepancy between the figures of the Bureau and of the Census may probably be explained on the basis of differences in classification.

In presenting its information, the Bureau relies upon two types of averages, the "aggregate, which is obtained by dividing the total dollars reported by firms for a particular item, say salaries and wages, by the total dollar sales of the same firms," and the median. This procedure is in accordance with its usual practice in its cost reports.

The present study shows a general summary of operating results for 1935, indicating that (a) the gross margin for this year is somewhat lower than for those immediately preceding; (b) the slight rise in expenses during the year was more than offset by the increase in sales so as to cause a slight decline in expense percentages; (c) those firms operating with a 25-cent limit enjoyed the highest profit rates; (d) the larger chains achieved a rate of net profit considerably in excess of that of the smaller systems, reversing the previous tendency in this respect.

The bulletin contains a new feature in the form of a study of the tax burden borne by this type of chain system. For the firms reporting, it amounted to 1.73 per cent of sales.

The report includes a study of the year-to-year trends of the several categories of operating statistics, a discussion of the effects on operating results of differences in price limitations on articles sold, a study of the effect upon such results which is exercised by (a) the volume of net sales per firm and (b) the number of stores per firm, the influence of the average sales per store, and the size of the city in which the store is located.

A section is devoted to a discussion of the relationship between so-called "store expenses" and "overhead costs." Another valuable chapter of the bulletin compares the operating data of each of several classes of chain systems grouped on the basis of number of stores conducted by each with the average figures for the three firms in each group having the highest rates of net profit. This information should be most useful to concerns other than the three highest in each class.

This study was made in cooperation with the Limited Price Variety Stores Association. It maintains the high quality of workmanship which has been set by the Bureau in preparing and presenting operating information concerning this and other types of retail establishments.

R. S. ALEXANDER

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Federal Support for Public Education, made under the direction of Paul R. Mort. New York: Bureau of Publications, Teachers College, Columbia University. 1936. xvi, 334 pp. $3.70.

A Measure of Taxpaying Ability of Local School Administrative Units, by Francis G. Cornell. New York: Bureau of Publications, Teachers College, Columbia University. 1936. viii, 114 pp. $1.60.

Professor Mort and his associates (Dr. Cornell, Professors Harry, Lawler, and Newcomer, and Commissioner Simpson) present in the first-mentioned book not only a program for Federal aid to education but also a formula for the distribution of such aid among the states. The minimum program proposed by Professor Mort calls for a distribution by the Federal Government of $300,000,000 annually. Each state is to receive from $6 to $12 per weighted pupil. The weighted pupil is a unit in which a high school pupil is considered as 1.7 of an elementary school pupil, and an adjustment is made to sparsity of population (necessitating substantial outlays for transportation) and to increased costs of living in urban places of different sizes. By computing the number of such weighted pupils in each state an index of the educational needs of the states is obtained.

The object of the minimum program is to guarantee to each state a school expenditure of at least $15 per weighted pupil and to equalize the state and

local contributions towards the support of this program in such a way that in no state would such contributions be in excess of the state's relative tax-paying ability. It appears that some states are now spending as little as $12 per weighted pupil, and in schools for colored children even less, and that even at that they are straining their resources, whereas other states are spending $60 per weighted pupil, without any difficulty. The proposed Federal aid would result not only in an increase in school expenditures in some states but, in some of them, also in a reduction in the amounts of money raised in them for school purposes. A maximum program of Federal aid would tend to guarantee to each state a school expenditure of $60 per weighted pupil and to equalize the state and local contributions on the basis of the relative abilities of the states to contribute toward such a program.

The bulk of the book is concerned with the construction of an index of the relative abilities of the states to raise money for school purposes under a national program. This index of ability is constructed on the basis of ten factors which are seemingly related to wealth and for which figures by states are available. These factors are: the amounts of income reported for Federal income tax purposes (the aggregates of the larger incomes being considered separately from the aggregates of incomes of medium size), postal receipts, value added by manufacture, retail sales, farm cash incomes, capital stock of domestic corporations, motor vehicle registration, and population (total and urban). In the case of each one of these factors the figures by states are expressed as percentums of the national total. Thus ten series of relatives are obtained, showing for each state its proportion of the particular total. Next, these series are weighted in the light of their correlation to (or deviation from) another index of ability. This other index is prepared on the basis of estimates of the relative amounts of revenue which six selected taxes would, together, produce in each state if levied at the same rate in all states. These taxes are: personal income, corporation income, real estate, corporation organization, stock transfer, and severance taxes. Here, too, the amounts for each state are expressed as percentages of a national total. By adding for each state some of the weighted proportions and subtracting from the result others, a single or combined index is finally obtained in which the ability of each state is expressed as a percentum of the ability of all of the states.

The factors selected for this index seem to be pertinent. But the statistical data available for them are not uniformly complete and reliable. The accuracy of the method of weighting the several series is open to questioning, for the weighting is based on the degree of correlation of the series involved to an index of ability which is prepared from incomplete data and cannot be considered altogether reliable. The fact that the particular series happens to bear a close correlation to that index is not necessarily a guarantee of its correctness. Also, it is not at all clear why, in the computation of the combined index, motor vehicle registration is considered as a negative index of wealth, substractable from the total.

The second book, by Dr. Cornell, is really a supplement to Professor Mort's volume, It is concerned with the problem of measuring the financial abilities of local school districts, as a basis for the distribution among them of state school aid under a state equalization program. The author assumes that the best criterion of ability in the case is the true value of taxable real estate contained in each district, inasmuch as the bulk of the local revenues is derived from the property tax. Since it is impossible to obtain reliable figures of the true value of real estate from the figures of the assessed value, the author attempts to construct such an index from figures which are supposed to bear a close relation to property values. These are: population, retail sales, motor vehicle registration, number of income tax returns, volume of agricultural, manufacturing and mining output, postal receipts, etc. He expresses these figures in terms of percentages of the state total, thus getting for each school district the percentum ratios of its population, retail sales, motor vehicle registration, etc., to the state population, state retail sales, state motor vehicle registration, etc. To each series he gives a certain weight or coefficient of correctness. Next he combines these weighted or corrected indices in a single index, in which the ability of each district is expressed as a percentum of the aggregate ability of all districts in the state. The author believes that the index thus evolved is reliable and can be used as a basis for apportionment not only of school funds but also of other state aid.

The two books, taken together, constitute a valuable contribution to the development of scientific techniques of measurement of state and local financial abilities and deserve careful study by all students of this challenging problem. Obviously, these techniques, even if correctly conceived, require for their successful utilization complete and reliable statistical data. The data now available are unfortunately incomplete and, often, unreliable. It is hoped that this gap will be corrected in the future.

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